

METROPOLITAN WATER
AND SEWERAGE BOARD

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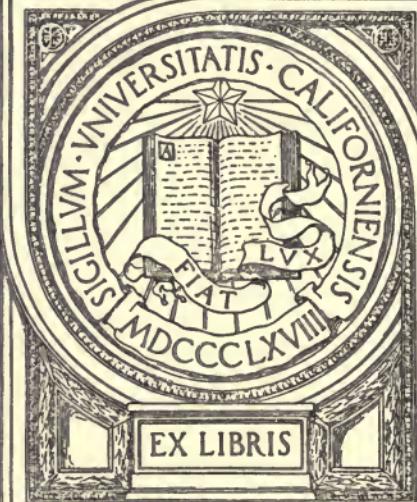
TENTH ANNUAL REPORT

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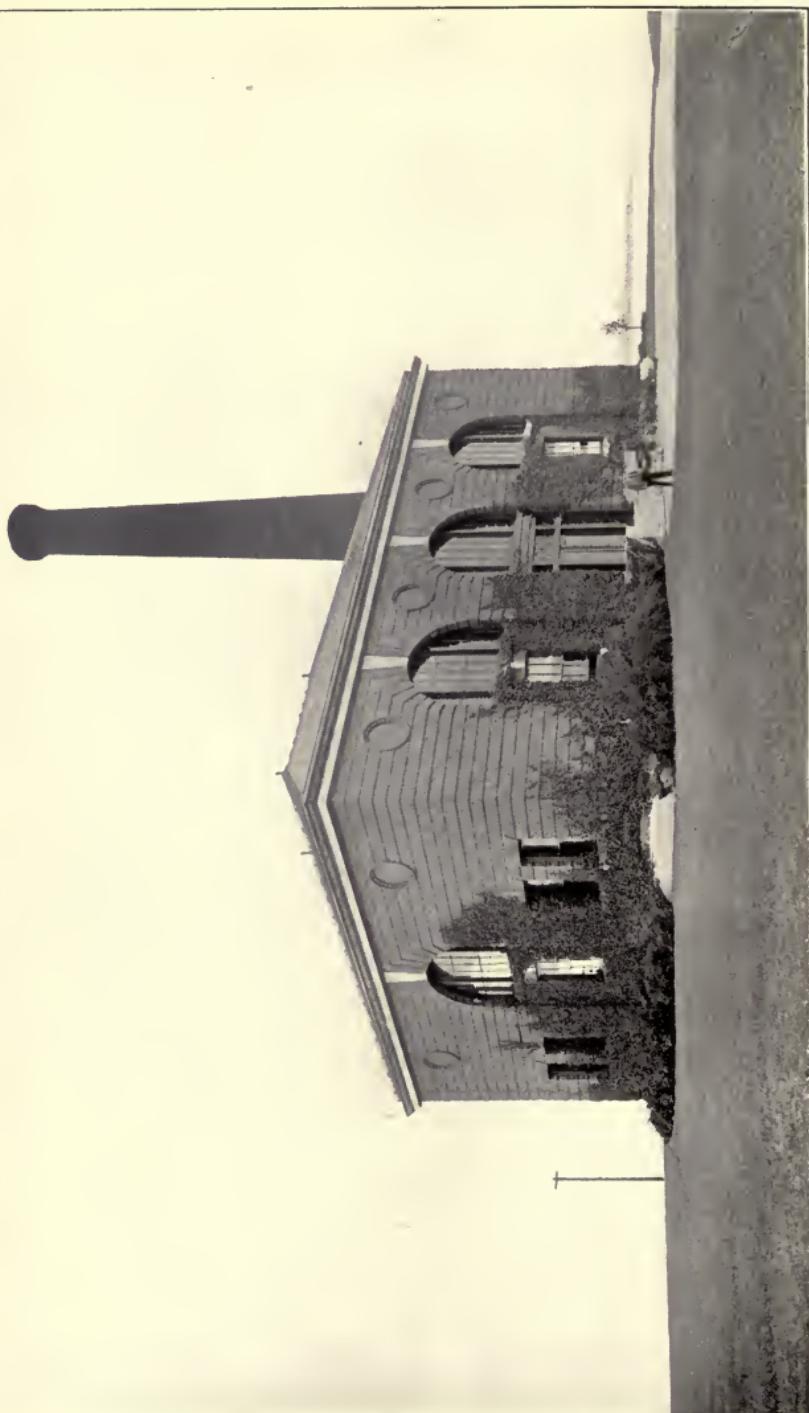
ARTHUR D. BUZBY, C. E.

UNIVERSITY OF CALIFORNIA
AT LOS ANGELES



GIFT OF
MR. C. W. COOK

ARTHUR D. BUZBY, C. E.



SCREEN HOUSE of HIGH-LEVEL SEWER AT NUT ISLAND.

ARTHUR D. BUZBY, C. E.

Public Document

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TENTH ANNUAL REPORT

OF THE

METROPOLITAN WATER AND SEWERAGE BOARD.

FOR THE YEAR 1910.



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METROPOLITAN WATER AND SEWERAGE BOARD.

To the Honorable the Senate and House of Representatives of the Commonwealth of Massachusetts in General Court assembled.

The Metropolitan Water and Sewerage Board, established under the provisions of chapter 168 of the Acts of the year 1901, has already presented to your Honorable Body an abstract of the account of its doings, receipts, expenditures, disbursements, assets and liabilities for the fiscal year ending on November 30, 1910, and now, in accordance with the provisions of chapter 235 of the Acts of the year 1906, it presents a detailed statement of its doings for the calendar year ending on December 31, 1910, being its

TENTH ANNUAL REPORT

made since the consolidation of the Metropolitan Water Board and the Board of Metropolitan Sewerage Commissioners on March 20, 1901.

I. ORGANIZATION AND ADMINISTRATION.

(1) BOARD, OFFICERS AND EMPLOYÉS.

The term of office of James A. Bailey, Jr., expired on March 21, 1910, and he was reappointed for the three years next succeeding. The membership of the Board has consequently remained as in the preceding year: Henry H. Sprague, chairman, Henry P. Walcott, M.D., and James A. Bailey, Jr. William N. Davenport has continued as secretary and in charge of the auditing department. Alfred F. Bridgman has been the purchasing agent and Miss Alice G. Mason the bookkeeper.

There are also employed in the administrative office a paymaster, an assistant in auditing, two general clerks, three stenographers and clerks, a telephone operator, a messenger, and a janitor with two assistants, one of whom acts as watchman.

George D. Bigelow, with the assistance of Miss Alline E. Marcy, has performed such general conveyancing work and made such further investigation of real estate titles in the different counties as has been called for during the year for the general purposes of the Board.

The consulting engineers of the Board are Hiram F. Mills and Frederic P. Stearns, who are called upon for services when matters arise which require such consideration.

Dexter Brackett, Chief Engineer of the Water Works, has had supervision over the various departments of both construction and maintenance. William E. Foss, as Assistant to the Chief Engineer, has exercised a general charge over engineering work in all departments. The following have also acted under direction of the Chief Engineer: Elliot R. B. Allardice, Superintendent of the Wachusett Department; Charles E. Haberstroh, Superintendent of the Sudbury and Cochituate Works and of the portion of the Weston Aqueduct above the Weston Reservoir; Samuel E. Killam, Superintendent in charge of the Weston Reservoir and the remaining portion of the Weston Aqueduct and of all reservoirs and pipe lines within the Metropolitan District; Arthur E. O'Neil, Superintendent of the several pumping stations; Alfred O. Doane, Division Engineer in charge of engineering work at pumping stations; Benjamin F. Hancox, Assistant in charge of the Drafting Department; Arthur W. Walker, Biologist; William W. Locke, in charge of the sanitary inspection of the watersheds; and William E. Whittaker, Office Assistant.

There has been a slight increase in the number in the engineering force on account of a greater amount of construction work in progress during the past year. The average force employed on construction and maintenance during the year has included, in addition to the Chief Engineer, 4 department superintendents, 2 division engineers, 6 assistant engineers, and 39 others in various engineering capacities and as sanitary inspectors, clerks, stenographers and messengers, the total force numbering 52. The maximum engineering force employed at any one time during the year on both construction and maintenance was 62.

A maintenance force in addition to those engaged in engineering

capacities as above mentioned, numbering upon the average during the year 249, has been required at the pumping stations, upon reservoirs, aqueducts, pipe lines, and upon minor construction work. At the end of the year this force numbered 244.

William M. Brown, Chief Engineer of the Sewerage Works, has had charge of both construction and maintenance. He has been assisted during the year by Frank I. Capen, Frederick D. Smith and Henry T. Stiff, Division Engineers, who have been in supervision of both construction and maintenance departments, by 1 assistant engineer and by 13 others employed in various engineering capacities, and by 2 clerks and stenographers.

The maximum engineering force employed at any one time during the year on construction and maintenance of Sewerage Works was 18.

The regular maintenance force required in addition for the operation of the pumping stations, the care and inspection of the sewers and for other parts of the Sewerage Works, exclusive of the engineers and day-labor forces, has upon the average numbered 148.

The whole regular force of the Sewerage Department at the end of the year numbered 167, of whom the Chief Engineer and 18 assistants and draftsmen were engaged in general upon the works, and, of the remainder, 90 were employed upon the North System and 58 upon the South System.

The day-labor forces under the supervision of the engineers and the immediate direction of the foremen have been employed during the year in connection with the extensions of the Deer Island and East Boston pumping stations and their equipment, in the building of the locker and stable buildings at East Boston, and in the completion of the pipe siphons under Alewife Brook.

The maximum number of men employed upon contracts and upon day-labor construction on the Sewerage Works during the year was for the week ending April 16, when the number amounted to 143.

(2) OFFICES AND BUILDINGS.

The offices of the Board and of the secretary, and of the auditing and conveyancing departments, and the main engineering offices of both Water Works and Sewerage Works, are located in the buildings

numbered 1 and 3 Ashburton Place, at the corner of Somerset Street, in Boston.

The headquarters of the Wachusett Department of the Water Works are at the gate and power house at the Wachusett Dam, in Clinton. The branch office for the Sudbury Department is maintained at South Framingham. Headquarters of the maintenance force of the Water Works for the northern part of the Metropolitan District are maintained in the Glenwood pipe yard in Medford, where there are offices, shops, store-rooms and stables; and the maintenance force for the southern part of the District has headquarters in like buildings at the Chestnut Hill Reservoir.

Branch headquarters of the maintenance and repair forces of the Sewerage Works are maintained for the North Metropolitan System in connection with the East Boston and Deer Island pumping stations, and for the South Metropolitan System at the Ward Street pumping station and at the storage yard at Hough's Neck.

II. METROPOLITAN WATER DISTRICT.

The Metropolitan Water District now comprises the cities of Boston, Chelsea, Everett, Malden, Medford, Melrose, Newton, Quincy and Somerville, and the towns of Arlington, Belmont, Hyde Park, Lexington, Milton, Nahant, Revere, Stoneham, Swampscott, Watertown and Winthrop,—in all 9 cities and 11 towns. The District has an area of 174.8 square miles, no additional municipalities having been admitted into the District during the year. Its population, according to the United States Census taken for April 1, 1910, was 1,070,256. The date upon which calculations for the Water Works are based is July 1, 1910, and the estimate of the population at that date is 1,076,650.

The city of Newton and the town of Hyde Park, though belonging to the District, have not made application to take water from the Metropolitan sources.

III. METROPOLITAN WATER WORKS—CONSTRUCTION.

The total amount expended for the construction and acquisition of the Metropolitan Water Works since the passage of the Metropolitan Water Act in the year 1895 has been \$41,546,929.56.

During the past year the amount of construction work has been considerably in excess of that of either of the previous four years. The total amount expended during the calendar year on account of the construction and acquisition of works has been \$502,624.92. There has been expended on account of the Wachusett Reservoir, principally in settlement of the claim for the taking of the St. John's Catholic Cemetery, the sum of \$35,955.26; the sum of \$275,381.04 in the laying of the new 60-inch main for bringing the supply of water from the Weston Aqueduct into the Metropolitan District; the sum of \$10,842.71 in the laying of a 16-inch force main in Arlington for the purpose of connecting the pumping station with the standpipe in that town; the sum of \$71,320.04 for the reinforcement of the supply of East Boston; the sum of \$22,577.50 for the northern high service, largely in the laying of a new 16-inch main in Lynn to reinforce the supply of the town of Swampscott; the sum of \$60,892.44 on account of the new pumping engine which is to be installed at Chestnut Hill for the use of the southern high-service district; and the remainder, the sum of \$25,655.93, has been expended for stock, other minor works and administration expenses.

(1) WACHUSSETT DAM AND RESERVOIR.

(a) *Power Plant.*

In accordance with the recommendations made by the Board the Legislature of the year 1910 passed a statute providing that the property held by the Metropolitan Water and Sewerage Board in the town of Clinton outside of the dam and dike, used in the generation and sale of electricity for power or for manufacturing purposes, shall be assessed on a valuation of \$125,000 in any year in which any power is generated and sold.

Before proceeding upon the construction of the power plant it had seemed necessary, inasmuch as the local tax upon such a plant would become so considerable an element in the cost of the power to be disposed of, that the valuation for taxation should be permanently established. The statute of 1910 further provided that the Board, before making a contract for the sale of the electricity, should make public request for proposals for its purchase. The

Board accordingly, after the passage of the act, proceeded to ask for proposals for the purchase of the electricity which might be generated, and as a result a five-year contract was made with the Connecticut River Transmission Company. It was provided in the contract that the Board should install a plant sufficiently large to develop the electric energy available from the fall of the water at the Wachusett Dam, and should also build a transmission line to connect with the transmission line erected by the company for the purpose of making a connection with the Lancaster Mills. The contract recognized that the amount of electric energy available from time to time during the year would be dependent upon the quantity of water which should be introduced into the aqueduct, and that this supply would be increased or diminished and at certain portions of the year wholly suspended, as might be necessary for the purposes of conserving the water supply of the Metropolitan District and utilizing the water supplied from sources nearer Boston.

The Board having made a contract for the sale of power proceeded at once to make plans and specifications for the installation of the necessary machinery in the power house at the foot of the dam. Proposals were invited from the leading hydraulic and electric manufacturing companies, and as a result a contract for installing the machinery required for the development of the power was made with the S. Morgan Smith Company of York, Pa., for both the hydraulic turbines and electric generators, it being understood that the electrical equipment would be furnished under a subcontract with the Westinghouse Electric & Manufacturing Company of Pittsburg, Pa. Work under the contract has already been begun, and its terms provide that it shall be so far completed that power can be furnished to the Transmission Company by July 1, 1911.

(b) St. John's Catholic Cemetery.

The Board was enabled on May last to bring about a final settlement under the agreement which had been made in the year 1898 with the Roman Catholic Bishop of the Diocese of Springfield and the St. John's Catholic Cemetery Association, by which the land acquired for the old cemetery in Clinton was taken for the Wachusett Reservoir and the bodies removed to a new cemetery site in Lancaster, purchased by the Board for the purposes of the Association.

A deed was received from the Bishop of the Diocese conveying the title to the land, and the Bishop and the Cemetery Association united in a release to the Commonwealth of all claims for damages by reason of the taking. The Board executed a deed to the Association of the cemetery lands in Lancaster and paid over to the Association the sum of \$32,096.83, the balance which had long remained payable under the terms of the agreement.

(2) IMPROVEMENT OF THE WATERSHEDS.

No large work has been undertaken during the past year for the improvement of the Wachusett watershed. Two small parcels of land, one of which afforded a menace to a brook emptying into the Wachusett Reservoir, and the other to the reservoir itself, have been purchased for the better protection of the water.. A small parcel in Marlborough was purchased for the protection of the Sudbury Reservoir, and four small strips of land along the shore of Lake Cochituate were also acquired to increase the marginal width of the lake.

The construction of a system for diverting the surface drainage of the village of Cochituate from the lake has been carried on by the maintenance department.

It has continued to be the policy of the Board to take such action as from time to time seems necessary in order to suppress the dangers which threaten the purity of the water.

(3) DISTRIBUTION SYSTEM.

(a) *New Weston Aqueduct Supply Main.*

The work of laying the 60-inch supply main which is to afford an additional connection between the Weston Aqueduct and the present mains near the Chestnut Hill Reservoir, and which was begun in the preceding year, has been prosecuted, and of the entire length of about 34,650 feet, 17,584 feet of iron pipe have been laid and 2,042 feet of tunnel have been excavated. The new main is located for the larger portion of the distance through Commonwealth Avenue, beginning near the Charles River in Newton and extending to the junction of Beacon Street and Chestnut Hill Avenue in Boston. It is contemplated at present to construct but a little more than 20,000 feet, being the lower portion ending near the Chestnut

Hill Reservoir, as it is deemed possible, owing to the reduction in the consumption of water in the District, to defer the completion of the remaining portion for the present. There remain principally to be completed in the part under immediate construction the masonry lining of the tunnel in Newton and the laying of 80-inch steel pipes at either end to make connection with the other portions of the line. The tunnel and connecting steel pipes have been made of a sufficient capacity to provide for another pipe line from the Weston Aqueduct in the future. The section under present construction will be brought to completion about the middle of the coming year.

(b) *New Force Main in Arlington.*

A 16-inch force main was laid during the year from Massachusetts Avenue in Arlington up to the standpipe on Arlington Heights, a distance of 3,750 feet. This main was laid in order to improve and make adequate the supply of the high-service districts in Arlington and Lexington and has been completed at a total cost of \$10,842.71, inclusive of engineering.

(c) *New Supply Main for East Boston.*

The Legislature of last year authorized the laying of an additional main in order to improve and render more secure the water supply of the East Boston district. For this purpose the Board has proceeded during the year to lay a main, in part 30 inches and in part 36 inches in diameter, from a connection with the Metropolitan main in Chelsea for a distance of about 3,800 feet to a point near the Chelsea Street Bridge, and thence through a tunnel for a distance of about 400 feet under Chelsea Creek to the East Boston side. The tunnel through which the pipe is laid has been constructed with an inner diameter of 6 feet 10 inches at a depth of about 50 feet below the surface of the creek at high water. The construction of the tunnel required the introduction of compressed air, and on account of the difficulty of the work it was determined to proceed by day labor. The tunnel and the laying of the pipe have been nearly completed and it is expected that water will be introduced through the new main early in the coming year.

(d) New 16-inch Main for Swampscott Water Supply.

As a part of the work which is deemed necessary in order to furnish a proper water supply to the town of Swampscott, a new 16-inch main has been laid through Ocean and New Ocean streets in Lynn to the Swampscott line. The entire cost of this work was \$14,009.70.

(e) New Pumping Engine at Chestnut Hill.

A contract for a new pumping engine having a capacity to pump 40,000,000 gallons per day was made in the year 1909. During the past year the parts of the engine have been received at the Chestnut Hill pumping station, where work of erection has been in progress as well as the construction of foundations for the engine and boilers. Although the engine is to be used for the supply of the southern high-service district it is located in the low-service pumping station. It is expected that the new engine will be placed in service early in the coming year.

(4) ACQUISITION OF LANDS AND SETTLEMENTS FOR DAMAGES.

During the past year the Board has further acquired in fee by purchase 62.706 acres of land, and by taking 0.624 of an acre. It has in addition acquired rights or easements by purchase in 0.133 of an acre, and by taking in 3.42 acres. The total acquisitions of land have thus amounted to 66.883 acres.

The lands acquired embraced three tracts, containing 62.159 acres in West Boylston for the protection of the Wachusett water supply; four parcels in Natick amounting to 0.547 of an acre for the protection of Lake Cochituate; a parcel of land containing 0.516 of an acre in Marlborough for the protection of the Sudbury Reservoir; several parcels in Newton having an aggregate of 3.202 acres for the 60-inch pipe line; a parcel of 0.401 of an acre in Arlington for the extension of the high service; and two parcels in Chelsea and East Boston of 0.0299 of an acre and 0.0325 of an acre, respectively, for the construction of the East Boston tunnel and pipe line.

Under the settlement which was made with the Roman Catholic Bishop of Springfield, a deed was received and a taking was made of the land formerly included in the St. John's Catholic Cemetery in Clinton, amounting to 26.39 acres, although this land had long been in possession of the Board.

The Board has conveyed away, as lands no longer required for its purposes, the lot in Clinton which was formerly occupied for offices for the sum of \$3,950; and also a parcel situated between Mystic Street and Old Mystic Street in Arlington for the sum of \$1,947. The settlement for the St. John's Catholic Cemetery lands included the release to the St. John's Catholic Cemetery Association of the parcel of land in Lancaster which had been acquired by the Board for the removal of bodies and held for cemetery purposes.

The settlements made during the past year on account of lands purchased and taken have numbered 13. The amount paid, including the balance of \$32,096.83 paid in the settlement for the St. John's Catholic Cemetery lands, was \$38,507.84. All these settlements have been effected by voluntary agreement.

There have been 9 takings of land for the Metropolitan Water Works, involving the taking in fee of 418.748 acres and easements and rights in 3.424 acres. The takings of lands in Sterling and West Boylston, and in Natick and Framingham, were of lands to which title by deed had previously been acquired. The following is a list of the takings made during the year for Water Works:—

Takings for Metropolitan Water Works for the Year 1910.

| No. | LOCATION AND DESCRIPTION. | Former Owner. | Recorded. | Purpose of Taking. |
|-----|---|--|------------------|---|
| 128 | Newton, — from Commonwealth Avenue northeasterly across Grant Avenue and Ward Street to Cochituate Aqueduct. Area, fee in 0.108 acre. Easements in 2.381 acres. Rights in 0.580 acre. | John Ward <i>et al.</i> , heirs of Francis Pettee, heirs of George K. Ward, William F. Harbach <i>et al.</i> , Nehemiah W. Rice <i>et al.</i> , Caroline R. Braiman and Charles G. Rice. | 1910. May 12. | Weston Aqueduct supply mains. |
| 129 | Arlington, — from Robbins Road to Park Avenue. Area, easements in 0.401 acre. | Within location of streets or private ways. | May 12. | Northern extra high-service pipe lines. |
| 130 | Sterling, — the John Gates farm and adjacent parcels on West Waushacum Pond. Area, fee in 230.71 acres. | Willie R. Mitchell <i>et al.</i> , Charles H. Baldwin and West Boylston Manufacturing Company. | May 23. | Improvement of Wachusett watershed. |
| 131 | Clinton, — the St. John's Catholic Cemetery. Area, fee in 26.39 acres. | The Roman Catholic Bishop of Springfield. | July 14. | Wachusett Reservoir. |
| 132 | Chelsea and East Boston, — parcels near Chelsea Street Bridge on Eastern Avenue, Chelsea, and Chelsea Street, East Boston. Area, easements in 0.0299 acre, Chelsea, and 0.0325 acre and temporary rights in 0.0131 acre, East Boston. | Albert D. Bosson <i>et al.</i> , and The Standard Oil Company of New York. | Aug. 13. | Low-service pipe lines. |
| 133 | Marlborough, — on an arm of Sudbury Reservoir, both sides of Mowry Brook. Area, fee in 0.516 acre. | The widow and heirs of Philip Mowry. | Sept. 1. | Sudbury Reservoir. |

Takings for Metropolitan Water Works for the Year 1910 — Concluded.

| No. | LOCATION AND DESCRIPTION. | Former Owner. | Recorded. | Purpose of Taking. |
|-----|--|--|-----------|---|
| 134 | Natick and Framingham, — outlying and marginal parcels on and near Speene Street and West Central Street, Natick, and on Pleasant Street, Framingham. Area, fee in 6.85 acres. | Westborough Savings Bank, Rufus G. Bayer <i>et al.</i> , D. J. Ferguson and Rebecca J. Belknap. | Nov. 1. | Improvement of Sudbury and Cochituate watersheds. |
| 135 | West Boylston and Sterling, — outlying parcels, Crescent Street, West Boylston, North Main Street, Oakdale, Waushacum Walk and West Waushacum Pond, Sterling. Area, fee in 16.554 acres. | Mary J. Warner, Walter B. Sawyer, Carrie E. Adams, Willie R. Mitchell <i>et al.</i> , and Elmer E. Towle <i>et al.</i> | Nov. 1. | Improvement of Wachusett watershed. |
| 136 | Sterling, — on East or West Waushacum ponds. Area, fee in 137.62 acres. | West Boylston Manufacturing Company, Frank L. Wilder <i>et al.</i> , Willie R. Mitchell and Agnes L. Benfield. | Dec. 21. | Improvement of Wachusett watershed. |

IV. WATER WORKS -- MAINTENANCE.

(1) OPERATION OF WORKS.

The maintenance of the Metropolitan Water Works has required the expenditure of \$414,121.52 during the past calendar year. There is involved the maintenance and operation of the various storage and distributing reservoirs and standpipes, aqueducts, pumping stations, main pipe lines, filter-beds, pipe yards, gate-houses, siphon and terminal chambers, dwelling houses for attendants, and buildings and other structures used or held for different operating purposes.

(2) STORAGE RESERVOIRS.

There are maintained the following reservoirs for the collection and storage of water in the various watersheds which serve as sources of supply for the distribution to the different municipalities: —

Cochituate watershed: —

Capacity in Gallons.

Lake Cochituate, including Dudley Pond, 2,242,400,000

Sudbury watershed: —

Sudbury Reservoir, 7,253,500,000

Framingham Reservoir No. 1, 287,500,000

Framingham Reservoir No. 2, 529,900,000

Framingham Reservoir No. 3, 1,180,000,000

Ashland Reservoir, 1,416,400,000

Hopkinton Reservoir, 1,520,900,000

Whitehall Reservoir, 1,256,900,000

Farm Pond, 167,500,000

Wachusett watershed: —

Wachusett Reservoir, 64,968,000,000

Total, 80,823,000,000

The full capacity of the reservoirs of 80,823,000,000 gallons was not reached during the year. The total quantity in storage at the beginning of the year was 62,101,500,000 gallons. The maximum quantity of 77,826,500,000 gallons was reached on May 10. During the latter half of the year there was a continual loss of storage, and at the end of the year the total quantity was 59,327,000,000 gallons, a net loss from the beginning of the year of 2,774,000,000 gallons.

The Wachusett Reservoir was not filled to high-water mark at any time during the year. At the beginning of the year the water was 12.91 feet below this mark, and reached its highest point on May 1, when its level was but 0.74 of a foot below high-water mark. There was a gradual loss during the latter part of the year, and at the end the reservoir was 15.65 feet below the high-water level and contained 45,610,400,000 gallons, showing a net loss during the year of more than 3,000,000,000 gallons.

The chief work which has been required in connection with the Wachusett Reservoir has been occasioned by the washing away of the soil at exposed places along the shore through the action of the waves. For an area along the reservoir nearly a mile in length it has been found necessary further to strip the soil in order to keep a proper marginal width.

In connection with the discharge of water from the reservoir into the river below, as required by the statute, a fountain has been installed in the pool, which has added an attractive feature to the grounds.

All the water taken from the Wachusett Reservoir was carried into the Sudbury Reservoir and thence in large part through Framingham Reservoir No. 3 into the Metropolitan District, and both these latter reservoirs were kept full or nearly full during the year.

It being deemed preferable to draw the water from the Wachusett supply, the other Framingham reservoirs and the Ashland, Hopkinton and Whitehall reservoirs, having independent sources, were not drawn upon during the year.

Water has been drawn from Farm Pond, through a filter gallery alongside of the pond, by the town of Framingham for the larger part of its supply, but a comparatively small portion has also been taken by the town directly from the Sudbury Aqueduct.

Several small strips of land along the shore of Lake Cochituate



IMPROVEMENT OF LAKE COCHITUATE—APPEARANCE SOUTH OF COUNTY ROAD
IN FRAMINGHAM BEFORE AND AFTER DRAINAGE WORK.

have been purchased during the year in order to add to the width of the marginal land under the control of the Board, and better to protect the water of the lake from pollution.

The principal measure, however, which has been taken for the protection of the water supply has been the construction of a system of surface drainage, which is to take the surface water from the village of Cochituate now flowing into Snake Brook, a tributary of the lake, and divert it into Bannister's Brook, which flows into the Sudbury River and outside of the Cochituate watershed. A large vitrified pipe is laid from Main Street in Cochituate village to the junction with Hammond's Brook, and thence a concrete covered drain 36 inches by 33 inches in dimensions has been constructed substantially along the County Road for a distance of 3,454 feet to a point beyond the town line of Natick, whence an open channel, with a bottom width of 12 inches, has been built for a distance of 5,958 feet, following an old drain to Bannister's Brook, and through the brook to an old mill-pond north of the County Road and west of Speene Street in Framingham.

The contract for this undertaking had been almost completed at the end of the year. An appropriation amounting to \$36,000, chargeable to maintenance, had been made for this improvement. The sum of \$26,883.44 has been so far expended, but the total cost will come considerably within the appropriation.

The prosecution of the work required the lowering of the water of the lake for a considerable period, and for this reason and on account of the excavation of the tunnel in Newton for the new 60-inch pipe in close proximity to the Cochituate Aqueduct, it has been deemed best not to draw water from Lake Cochituate, as has been usually done during a portion of the year.

(3) AQUEDUCTS.

Nearly all the water consumed in the Metropolitan District was brought from the Wachusett Reservoir, and consequently was carried through the Wachusett Aqueduct into the Sudbury Reservoir. The average number of gallons per day thus carried through the Wachusett Aqueduct was 103,146,200. The Wachusett Aqueduct was in operation during 340 days in the year.

From the Sudbury Reservoir water was discharged into Framing-

ham Reservoir No. 3, and thence an average of 85,033,000 gallons per day was drawn through the Sudbury Aqueduct to the Chestnut Hill Reservoir. This aqueduct was in continuous service during the entire year.

The Weston Aqueduct was also continuously operated during the year, and the daily average flow was 28,974,000 gallons. This water was taken directly from the Sudbury Reservoir.

No water was drawn through the Cochituate Aqueduct for the use of the District during the year, but the aqueduct was kept in condition ready for use if called upon at any time.

(4) DISTRIBUTING RESERVOIRS AND STANDPIPES.

The distributing reservoirs and standpipes located in different parts of the Metropolitan District have a total capacity of 2,381,230,000 gallons. These reservoirs are kept substantially full during the year, not only as a protection and relief in cases of accident or emergency, but also in order to secure a proper distribution of the water throughout the District. They are as follows:—

| | Capacity in Gallons. |
|------------------------------------|----------------------|
| Spot Pond, | 1,791,700,000 |
| Chestnut Hill Reservoir, | 300,000,000 |
| Weston Reservoir, | 200,000,000 |
| Fells Reservoir, | 41,400,000 |
| Mystic Reservoir, | 26,200,000 |
| Waban Hill Reservoir, | 13,500,000 |
| Forbes Hill Reservoir, | 5,100,000 |
| Bear Hill Reservoir, | 2,450,000 |
| Arlington Standpipe, | 550,000 |
| Forbes Hill Standpipe, | 330,000 |
| Total, | 2,381,230,000 |

(5) PUMPING STATIONS.

While about one-quarter of the water introduced into the Metropolitan District has been supplied by gravity, the remainder, or three-quarters of the whole, has been lifted by pumping at the two Chestnut Hill stations in order that it may be delivered in the various portions of the District at the requisite pressure. A portion

of the water is necessarily lifted a second time for the supply of the higher sections.

The following are the several pumping stations:—

| | Number of Engines. . | Maximum Contract Capacity per Day (Gallons). | Lift (Feet). |
|---|----------------------------|--|--------------|
| Chestnut Hill High-service Station, . . . | 4 ¹ | 66,000,000 | 138 |
| Chestnut Hill Low-service Station, . . . | 3 | 105,000,000 | 60 |
| Spot Pond Station, | 2 | 30,000,000 | 125 |
| Arlington Station, | 2 | 3,000,000 | 290 |
| West Roxbury Station, | 3 | 3,750,000 | 140 |

¹ The new pumping engine in process of erection for the high service, to be located in the low-service station, will have a maximum contract capacity of 40,000,000 gallons per day, with a lift of 130 feet.

An average of 84,654,000 gallons was daily pumped from the two Chestnut Hill stations, and in the other stations an average of 8,995,000 gallons was daily pumped.

The total cost of operating all the stations during the year was \$101,996.34, or \$2.99 per million gallons pumped. Of this total, \$61,933.82 was expended for labor and \$34,332.78 for fuel.

The total amount of coal purchased during the year was 9,693.63 gross tons, of which 6,941.47 tons were bituminous, 314.53 tons anthracite, 2,101.77 tons buckwheat anthracite, and 335.86 tons anthracite screenings. The average cost of bituminous coal delivered in the bins at the various stations varied from \$3.85 to \$4.82; the average cost of anthracite coal was \$4.91; the cost of buckwheat varied from \$2.59 to \$2.76, and of anthracite screenings from \$2.50 to \$2.68.

All the bituminous coals purchased are subjected on delivery to strict tests as to their heating power and as to the amount of moisture contained, and it is provided in the contracts for furnishing the coal that a deduction shall be made when the coal falls below a fixed standard, and at the same time the price is increased if it is found to be superior to the standard required.

(6) PIPE LINES.

There has been during the past year an increase in the length of main pipe lines owned and operated by the Metropolitan Water and Sewerage Board of 4.49 miles, the total length of the mains now owned and in operation being 97.02 miles. The Metropolitan mains are operated in connection with local mains 4 inches and more in diameter, by which the water is distributed to the various municipalities of the District, and which have a length of 1,633.37 miles.

The principal addition to the mains has been the laying of about $2\frac{1}{3}$ miles of the 60-inch supply main from the Weston Aqueduct, but the new line for the improvement of the East Boston supply, the line in Lynn for the reinforcement of the Swampscott supply, and the line between the pumping station and standpipe in Arlington, have added considerable to the total mileage.

Several changes in mains have been required during the past year, largely on account of construction of other public works.

The construction of the subway station at Harvard Square in Cambridge by the Boston Elevated Railway Company compelled a change in the 48-inch main running through Boylston Street and Massachusetts Avenue for a distance of about 650 feet. For a portion of the distance three 24-inch mains were substituted for the original 48-inch main. This work involved much difficulty, and was performed in part by the Board at the expense of the company and in part by the Boston Elevated Railway Company itself.

Other changes found necessary have been the lowering of the 48-inch main in Reservoir Lane in Brookline near the Chestnut Hill high-service pumping station for a distance of 275 feet, in order to permit the construction of Crafts Road across the lane; the lowering of the pipe under the Mystic River between Medford and Arlington for a distance of 130 feet to permit the deepening of the channel by the Metropolitan Park Commission; and a relocation of the main in Morton Street in West Roxbury in order to conform to the new location of a branch of the Stony Brook conduit made by the city of Boston.

It has also been necessary to relay a portion of the 48-inch main in Boylston Street, Cambridge, on account of the destructive effects of electrolysis upon the pipes.

SUBSTITUTING THREE 24-INCH PIPES FOR 48-INCH PIPE IN MAIN AT HARVARD SQUARE, CAMBRIDGE.



No breaks in the mains have occurred during the year, but there have been discovered and repaired 45 leaks in pipe lines. Several of the leaks occurred in the pipes laid under the Charles and Mystic rivers, and in the repairs resort was necessarily had to dredging machines and divers. The larger part of the leaks occurred at leaded joints, and were in many cases due to settlement of the pipes on account of adjacent excavations made in the prosecution of other public work.

The Venturi and other meters, by which the water delivered to the various municipalities is measured, have been the efficient means of detecting leaks in the local systems which failed to be discovered by the authorities themselves. Two notable leaks, in each case amounting to about 1,000,000 gallons per day, were, through the indications of the meters, found in Medford and in Brighton, the water escaping in one case into the river and in the other into a sewer.

(7) CLINTON SEWERAGE WORKS.

The Clinton Sewerage Works have been operated under the requirements of the Metropolitan Water Act in order to dispose of the sewage of the town, which had formerly been discharged into the South Branch of the Nashua River before the principal portion of the water was diverted for the Metropolitan supply.

About 829,000 gallons of sewage per day have been pumped upon the filter-beds, at a total cost of \$3,545.92, or of \$11.72 per million gallons pumped.

A considerable improvement in the efficiency of the filter-beds has been effected by continuing the work previously begun of constructing underdrains and of placing distributing channels over the surfaces of the beds.

In addition to the 29 beds before constructed, 2 new beds have been built during the past year in a more isolated location in order to receive the sludge from the settling basins, into which the sewage is directly pumped.

The measures which have been taken have brought about a decided improvement in the character of the effluent discharges. The sludge which has gathered has been used as fertilizer for the grass lands in the vicinity of the Wachusett Dam and the North Dike.

The sum of \$3,353.42 was expended in the required maintenance of the filter-beds, and an additional sum of \$4,895.61 was spent upon the improvements.

(8) PROTECTION OF THE WATER SUPPLY.

Various means have been employed in connection with the maintenance of the works in order to preserve the purity of the water supplied to the District and to protect it from pollution.

(a) *Pegan Brook Filtration Works.*

In the work of protecting the waters of Lake Cochituate about 577,550 gallons per day of the surface drainage which comes from the more thickly settled portions of the town of Natick have been collected and pumped upon filter-beds before the water of the brooks intercepted is allowed to enter the lake. The cost of maintaining and operating the pumping station and the filter-beds has been \$2,606.47, or \$12.77 per million gallons treated.

(b) *Marlborough Brook Filter-beds.*

The surface water from the thickly settled portions of the city of Marlborough, flowing into Marlborough Brook, has been diverted into a settling basin and thence into filter-beds, before it has been admitted into the Sudbury Reservoir. During a few days only in the year has diluted sewage overflowed from the Marlborough sewer mains into the brook. The filters have been sufficient to dispose of all the waters of the brook except upon two days of heavy storm.

(c) *Sterling Filter-beds.*

The filter-beds constructed on the brook which flows through the centre of the town of Sterling and into Lake Waushacum have been in continuous and successful operation through the year. The smaller filter-beds at Sterling Junction, which were built to intercept the sewage of the summer cottages and prevent the pollution of the Waushacum Brook, a direct tributary of the Wachusett Reservoir, have been kept in operation during the summer season.

(d) Drainage Ditches.

The ditches which have been built for an aggregate length of 36.36 miles, in order to provide a quick drainage of the principal swamps upon the several watersheds and to prevent the discoloration and deterioration of the water flowing from them into the various storage reservoirs, require from year to year not only regular oversight but many repairs and renewals. These have involved a considerable expense, amounting to \$2,315.65, but the result has been satisfactory in the improvement of the quality of the water.

(e) Sanitary Inspection and Policing.

A sanitary inspector, William W. Locke, C.E., and one assistant have been continuously engaged, and others to the maximum of 15 in number have been employed for various periods during the year, in the inspection of the watersheds, not only for the purpose of remedying minor sources of pollution but also for the more general protection from injury of the property of the Commonwealth.

The sanitary inspectors have examined 1,481 premises on the Wachusett watershed and 7,226 premises on the Sudbury and Cochituate watersheds with reference to cesspools, privy, sink and barn drainage, manufacturing wastes and sewer connections.

During the year a census has been made, showing in the different sections of the watersheds the permanent and summer populations, the number of dwellings occupied permanently and in the summer, the population unconnected with sewers, and the numbers of domestic animals which are kept. The tables, which are given in the report of the Chief Engineer of Water Works, indicate a decided improvement in the sanitary condition of the watersheds during the last five years, and show that the number of premises deemed "unsatisfactory," that is, those from which trouble may possibly arise under unfavorable circumstances, have been greatly reduced.

These tables show that upon the Wachusett watershed the total permanent population is 44.7 per square mile of area, and that on the Sudbury and Cochituate watersheds the population in dwellings not connected with sewers is respectively 129.7 and 260.4 per square mile.

There were 3 cases of typhoid fever reported on the Wachusett

watershed and 130 cases upon the Sudbury and Cochituate watersheds. All these cases were carefully watched, and measures, which were entirely successful, were adopted to prevent the pollution of the water supply.

A more general patrol for the protection of the water supply has been required during more or less of the year. Three officers are regularly employed in the policing of the Wachusett and Sudbury systems, though other duties are assigned them in connection with this employment. Two watchmen were employed about Lake Cochituate in the summer and camping season and while a large gang of laborers was engaged on public works in the vicinity. The large number of persons visiting the grounds about the Chestnut Hill reservoirs and Spot Pond in the summer season has made it necessary, for the more effective protection both of the water supply and of the property of the Commonwealth, to employ patrolmen more or less on Saturdays, Sundays and holidays, and for the purpose men have generally been detailed from other duties. These various efforts have been successful in preventing any serious injury.

(f) Laboratory Examinations.

Weekly and monthly examinations are made in the laboratory of the Board to ascertain the number of organisms and bacteria contained, and to determine the color, taste, odor and turbidity of the water of the various reservoirs and of the various tributaries which feed the larger sources from which the supply is taken. There have thus been made 2,377 microscopical and 961 bacterial examinations during the year. Samples are also sent for monthly and bi-monthly chemical examination at the laboratory of the State Board of Health. These examinations not only enable the quick detection of objectionable organisms or other substances in the water, but make it possible to draw the water for immediate use in a large measure from sources where the most favorable conditions exist.

(9) QUALITY OF THE WATER.

The water drawn from the Wachusett and Sudbury reservoirs, which have furnished almost the entire supply during the year, has been peculiarly free from objectionable organisms. Other disturbing elements have also been lacking, and the water furnished the District has been of exceptionally good quality.

(10) FORESTRY AND MOTH SUPPRESSION.

The lands under the custody of the Board comprise about 10,000 acres, and the larger part of these are embraced in the margins surrounding the great reservoirs, particularly the Wachusett Reservoir. For the better protection of the water of the reservoirs it has been the policy of the Board to plant with trees the larger part of the territory which was not already wooded. The original nurseries, the Lamson and Flagg nurseries, maintained on the north and south sides of the Wachusett Reservoir, will gradually give way to a single new nursery which has been started on Waushacum Street in Oakdale.

The work about the Wachusett Reservoir during the past year has consisted principally in replanting sections along the immediate margins in order to supply the places of trees which had died, the thinning out of portions of the old woodlands, the improvement of forest roads and the planting of trees along the highways.

A considerable number of arbor vitæ trees have been set out on the shores and lands about the Sudbury Reservoir, white pines have been planted on portions of the shore about Lake Cochituate and along the Sudbury Aqueduct, and other trees have been set out along the Weston Aqueduct and at Spot Pond.

The ravages of the gypsy and brown-tail moths, the elm-leaf beetle and the pine-tree weevil have continued on various parts of the lands under the custody of the Board, and the sum of \$6,010.21 has been spent in the efforts to suppress them, an amount about \$2,000 less than that called for in the preceding year.

The moths have been encountered, though in somewhat less numbers, at Spot Pond, at the Chestnut Hill Reservoir, and also at the Sudbury and Weston reservoirs, and along portions of the aqueducts. A few moths have been discovered the past year in the vicinity of the Wachusett Reservoir. At the Weston Reservoir the elm-leaf beetle has been more than ever prevalent and destructive. At the Wachusett Reservoir the pine-tree weevil infested the young pines more than in previous years, and it was also alike destructive at the Sudbury Reservoir.

(11) ELECTROLYSIS.

Owing to the destructive effects of the passage of the electric currents through the line of iron pipes, it was deemed unsafe to defer

longer the substitution of new pipes in that section of the 48-inch main line which runs through Boylston Street in Cambridge from the vicinity of the power station of the Boston Elevated Railway Company near the Charles River, to Eliot Street, not far from Harvard Square. The section replaced had a length of 827 feet and had been laid but a period of fourteen years. The new pipes have a thickness of 1.7 inches instead of the original thickness of 1.4 inches and, excepting at a curve, were laid with joints of wood instead of lead in order to secure insulation in the future. Pittings more or less deep and extended were found in all the discarded pipes, generally from $\frac{1}{2}$ inch to at least 1 inch in depth. In one of the lengths removed the pipe was so affected that four holes were made in cleaning out the pittings which had been caused by the action of the electric current.

The cost of relaying this section of the main was \$12,221.40, and is made a claim against the Railway Company.

The insertion of wooden instead of lead joints at intervals of about 500 feet has been adopted in all the lines of main pipe which have been recently laid, and it is believed that this is the most efficient means for the prevention or checking of electrolysis in the pipes which has yet been found.

It is undoubtedly true, however, that great damage has been done in the past by the electrolytic action upon the pipes in various parts of the District, seriously weakening them in case of extraordinary pressure and decidedly shortening the period of their safe use.

V. WATER WORKS — FINANCIAL STATEMENT.

The financial abstract of the receipts, disbursements, assets and liabilities of the Board for the State fiscal year, beginning with December 1, 1909, and ending with November 30, 1910, was, in accordance with the requirements of chapter 235 of the Acts of the year 1906, presented to the General Court in January last, and a copy of this financial abstract is printed as Appendix No. 5.

The more detailed statement of its doings required by said chapter for the calendar year 1910, in relation to the Metropolitan Water Works, is herewith presented.

The Metropolitan Water Loans authorized for the construction and acquisition of works have amounted to \$41,878,000. To this

EFFECT OF ELECTROLYSIS UPON 48-INCH MAIN PIPE IN Boylston STREET, CAMBRIDGE.



sum are added the proceeds from the sale of property by the Board, and these amounted on January 1, 1911, to \$288,574.04. The total amount, therefore, which the Board has been authorized to expend is \$42,166,574.04. The amount of expenditures approved by the Board for payment out of the Metropolitan Water Loan Fund was, for the year 1910, \$502,624.92, and the total amount so approved for payment since the beginning of the work up to January 1, 1911, has been \$41,546,929.56. There was accordingly a balance remaining at the beginning of the year 1911 amounting to \$619,-644.48.

The Treasurer of the Commonwealth has issued from time to time, on the request of the Board, bonds to the amount of \$41,398,000. These bonds were issued for terms of thirty-nine and one-half and forty years from the date of issue, and bear interest at the rate of 3 per cent. and $3\frac{1}{2}$ per cent. per annum. The sinking fund established for the payment of the bonds at maturity amounted on January 1, 1911, to \$8,089,902.91.

The increase in the debt, during the calendar year, as represented by the Metropolitan Water Loans outstanding, was \$500,000. The increase of the sinking fund for the payment of the debt at maturity was during the same period, \$863,640.60. There has been, therefore, a decrease of the net debt during the calendar year amounting to \$363,640.60.

The amount approved by the Board for the maintenance and operation of the Water Works for the year 1910, which was paid out of the annual assessments, was \$414,121.52.

The assessments for the year 1910 for the payment of interest on the bonds, for the sinking fund requirements and for the expenses of operation and maintenance of the Water Works, which were levied upon the various cities and towns in the Metropolitan District, amounted to \$2,297,787.77.

(1) METROPOLITAN WATER LOANS, RECEIPTS AND PAYMENTS.

The loans authorized for the construction and acquisition of the Metropolitan Water Works, the receipts which are added to the proceeds of these loans, the expenditures for the construction and acquisition of works, and the balance available on January 1, 1911, have been as follows:—

METROPOLITAN WATER

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| | |
|---|-----------------|
| Loan under chapter 488 of the Acts of 1895, | \$27,000,000 00 |
| Loan under chapter 453 of the Acts of 1901, | 13,000,000 00 |
| Loan under chapter 367 of the Acts of 1906, | 500,000 00 |
| Loan under chapter 558 of the Acts of 1908, | 398,000 00 |
| Loan under chapter 320 of the Acts of 1909, | 900,000 00 |
| Loan under chapter 291 of the Acts of 1910, | 80,000 00 |
| | <hr/> |
| | \$41,878,000 00 |

Receipts from the sales of property applicable to the construction and acquisition of works:—

| | |
|--|-------------|
| For the year ending December 31, 1910, | \$31,502 38 |
| For the period prior to January 1, 1910, | 167,071 66 |
| | <hr/> |
| | 198,574 04 |

Receipt from town of Swampscott for admission to the Metropolitan Water District paid into Loan Fund (St. 1909, c. 320),

90,000 00

\$42,166,574 04

Amount approved by the Metropolitan Water and Sewerage Board for payments out of the Water Loan Fund:—

| | |
|--|---------------|
| For the year ending December 31, 1910, | \$502,624 92 |
| For the period prior to January 1, 1910, | 41,044,304 64 |
| | <hr/> |
| | 41,546,929 56 |

Balance January 1, 1911, \$619,644 48

(2) ISSUES OF METROPOLITAN WATER LOAN BONDS.

The Treasurer of the Commonwealth, under the authority given him to issue from time to time, on the request of the Board, negotiable bonds to an amount not exceeding \$41,878,000, to be designated the "Metropolitan Water Loan," has sold bonds to the amount of \$41,398,000. The list of bonds sold prior to the year 1910 is given in the last (Ninth) Annual Report. The bonds sold in the year 1910 are as follows:—

| DATE OF SALE. | Amount of Bonds sold. | Rate of Interest (Per Cent.). | Price received. | Date due. | Premium. |
|--------------------------|-----------------------|-------------------------------|-----------------|--------------|------------|
| Feb. 10, 1910, | \$500,000 | 3½ | 100.39 | Jan. 1, 1950 | \$1,950 00 |

Prior to May 1, 1906, all premiums received from the sales of bonds were applied to the payment of the current charges in re-

duction of the annual assessments, but since that date, under the provisions of chapter 337, Acts of 1906, they have been paid into the sinking fund.

(3) METROPOLITAN WATER LOAN SINKING FUND.

The sinking fund established by the Treasurer of the Commonwealth has amounted at the end of each year to sums as follows:—

| | | | |
|----------------------|--------------|----------------------|----------------|
| December 31, 1895, . | \$226,286 05 | December 31, 1903, . | \$2,877,835 59 |
| December 31, 1896, . | 699,860 70 | December 31, 1904, . | 3,519,602 92 |
| December 31, 1897, . | 954,469 00 | December 31, 1905, . | 4,207,045 69 |
| December 31, 1898, . | 1,416,374 29 | December 31, 1906, . | 4,897,822 62 |
| December 31, 1899, . | 1,349,332 97 | December 31, 1907, . | 5,643,575 69 |
| December 31, 1900, . | 1,573,619 72 | December 31, 1908, . | 6,419,283 28 |
| December 31, 1901, . | 1,662,426 95 | December 31, 1909, . | 7,226,262 31 |
| December 31, 1902, . | 2,283,803 81 | December 31, 1910, . | 8,089,902 91 |

ARTHUR D. BUZBY.

(4) ANNUAL ASSESSMENTS AND RECEIPTS.

Assessments for the year, amounting to \$2,297,787.77, were required for the payment of the interest on the bonds issued by the Commonwealth, the sinking fund requirements and the expenses of operation and maintenance of the Water Works. The requirements were: for interest, \$1,395,201.95; for the sinking fund, \$522,344.24; and for maintenance and operation, \$380,241.58. These assessments were made by the Treasurer of the Commonwealth upon the various municipalities as follows:—

| | | | |
|------------------|--------------|-------------------|----------------|
| Arlington, . . . | \$16,241 07 | Nahant, . . . | \$4,357 11 |
| Belmont, . . . | 6,812 68 | Newton, . . . | 6,370 34 |
| Boston, . . . | 1,815,658 85 | Quiney, . . . | 50,950 31 |
| Chelsea, . . . | 47,716 42 | Revere, . . . | 23,139 93 |
| Everett, . . . | 45,937 13 | Somerville, . . . | 110,056 25 |
| Hyde Park, . . . | 1,316 24 | Stoneham, . . . | 9,670 13 |
| Lexington, . . . | 7,501 34 | Swampscott, . . . | 9,547 88 |
| Malden, . . . | 42,302 82 | Watertown, . . . | 16,082 35 |
| Medford, . . . | 32,690 39 | Winthrop, . . . | 16,681 77 |
| Melrose, . . . | 19,640 91 | | |
| Milton, . . . | 15,113 85 | | \$2,297,787 77 |

The comparatively smaller sums assessed upon the city of Newton and the town of Hyde Park were owing to the fact that neither of

these municipalities had reached the safe capacity of its own sources of water supply, and neither had been furnished with water.

The proceeds from the operations of the Board, exclusive of the proceeds from sales of property and of water, are required by statute to be applied to the payment of the interest, the sinking fund requirements and expenses of maintenance and operation of works. These for the year 1910 amounted to \$26,929.32.

The amount approved by the Board for the maintenance and operation of the Metropolitan Water Works was, for the year 1910, \$410,-121.52.

(5) SUPPLYING WATER TO CITIES AND TOWNS OUTSIDE OF DISTRICT AND TO WATER COMPANIES.

Sums have been received during the year 1910, under the provisions of the Metropolitan Water Act, for water furnished, as follows:—

| | |
|---------------------------------------|------------|
| Town of Framingham, | \$559 20 |
| United States Government, | 1,954 46 |
| Westborough State Hospital, | 1,433 88 |
| | <hr/> |
| | \$3,947 54 |

The sums so received prior to March 23, 1907, were annually distributed among the cities and towns of the District, but since that date, in accordance with the provisions of chapter 238 of the Acts of 1907, the sums so received have been paid into the sinking fund.

(6) EXPENDITURES FOR THE DIFFERENT WORKS.

The following is a summary of the expenditures made in the various operations for the different works:—

| CONSTRUCTION AND ACQUISITION OF WORKS. | For the Year ending December 31, 1910. | From Beginning of Work to December 31, 1910. |
|--|--|--|
| Administration applicable to all parts of the construction and acquisition of the works, | \$6,999 78 | \$288,453 07 |
| Wachusett Dam and Reservoir:— | | |
| Wachusett Dam, | \$288 27 | \$2,378,195 28 |
| Power plant, | 2,243 06 | 2,436 06 |
| North Dike, | — | 792,264 68 |
| South Dike, | — | 137,075 55 |
| <i>Amounts carried forward,</i> | \$2,531 33 | \$3,309,971 57 |
| | \$6,999 78 | \$288,453 07 |

| CONSTRUCTION AND ACQUISITION OF WORKS. | For the Year ending December 31, 1910. | | From Beginning of Work to December 31, 1910. | |
|---|--|-------------|--|-----------------|
| <i>Amounts brought forward,</i> | \$2,531 33 | \$6,999 78 | \$3,309,971 57 | \$288,453 07 |
| Wachusett Dam and Reservoir — <i>Concluded.</i> | | | | |
| Removal of soil, | | - | 2,536,612 66 | |
| Relocation of railroads, | | - | 881,872 45 | |
| Roads and bridges, | | - | 547,867 76 | |
| Real estate, | 33,423 93 | | 3,240,189 06 | |
| Damages, real estate not taken, business and loss of wages, | | - | 532,247 07 | |
| Other expenses, | | - | 8,547 92 | |
| | 35,955 26 | | 11,057,308 49 | |
| Improving Wachusett watershed, | 2,636 20 | | 231,128 77 | |
| Wachusett Aqueduct, | | - | 1,797,948 85 | |
| Sudbury Reservoir, | 13 25 | | 2,923,146 96 | |
| Protection of Sudbury supply, | | - | 129,190 36 | |
| Improving Sudbury watershed, | | - | 95,711 84 | |
| Protection of Cochituate supply, | | - | 9,000 00 | |
| Improving Cochituate watershed, | | - | 8,860 68 | |
| Improving Lake Cochituate, | | - | 104,141 29 | |
| Pipe lines, Dam No. 3 to Dam No. 1, | | - | 48,471 48 | |
| Pipe line, Rosemary siphon, | | | 23,142 98 | |
| Weston Aqueduct:— | | | | |
| Aqueduct, | - | | \$2,353,820 11 | |
| Reservoir, | - | | 289,001 82 | |
| Real estate, taxes and other expenses, | - | | 206,668 18 | |
| | | | 2,849,490 11 | |
| Distribution system:— | | | | |
| Low service:— | | | | |
| New 48-inch main, Section 31, | - | | \$162,698 06 | |
| Section 38, Tunnel (East Boston main), . . . | \$32,322 27 | | 32,322 27 | |
| Pipe lines and connections, | 38,957 77 | | 1,791,985 02 | |
| Pumping station, Chestnut Hill, | - | | 462,572 19 | |
| Reservoir, Spot Pond, | - | | 582,188 73 | |
| Gate-house and connections, Chestnut Hill Reservoir, | - | | 65,480 88 | |
| Real estate and other expenses, | 1,210 61 | | 92,936 17 | |
| Northern high service:— | | | | |
| Pipe lines and connections, | 22,577 50 | | 527,485 76 | |
| Spot Pond pumping station, | - | | 291,829 35 | |
| Fells Reservoir, Stoneham, | - | | 141,392 94 | |
| Bear Hill Reservoir, Stoneham, | - | | 38,267 70 | |
| Real estate and other expenses, | - | | 14,838 05 | |
| Southern high service:— | | | | |
| Pipe lines and connections, | 350 12 | | 516,211 06 | |
| Pumping station, Chestnut Hill, | 60,542 32 | | 307,694 70 | |
| Forbes Hill Reservoir, Quincy, | - | | 90,003 49 | |
| Waban Hill Reservoir, Newton, | - | | 61,592 11 | |
| Real estate and other expenses, | - | | 10,226 36 | |
| <i>Amounts carried forward,</i> | \$155,980 59 | \$45,604 49 | \$5,189,724 84 | \$19,565,994 88 |

| CONSTRUCTION AND ACQUISITION OF WORKS. | For the Year ending December 31, 1910. | From Beginning of Work to December 31, 1910. |
|---|---|---|
| <i>Amounts brought forward,</i> | \$155,960 59 | \$45,604 49 |
| Distribution system — <i>Concluded.</i> | | |
| Northern extra high service, | 10,842 71 | 101,797 77 |
| Southern extra high service, | 16 00 | 22,871 27 |
| Weston Aqueduct supply mains, | 275,671 44 | 959,425 58 |
| Meters and connections, | 2,170 11 | 84,615 69 |
| Improving Spot Pond Brook, | — | 3,991 23 |
| Glenwood pipe yard, | — | 33,100 59 |
| Chestnut Hill pipe yard, | — | 11,311 26 |
| | 444,660 85 | 6,406,838 23 |
| Stock — pipes, valves, castings, etc., purchased and sent first to storage yards, and later transferred, as needed, to the various parts of the work: — | | |
| Amount received, | \$199,162 23 | \$2,471,141 97 |
| Transferred from storage yards to the various sections of the work and included in costs of special works, | 186,802 65 | 2,320,946 81 |
| | 12,359 58 | 150,195 16 |
| Diversion of water, South Branch of Nashua River, ¹ | | 1,363,935 31 |
| Acquisition of existing water works: — | | |
| Reimbursement city of Boston, partially constructed Reservoir, | — | \$1,157,921 59 |
| Boston water works, taken January 1, 1898, | — | 12,768,948 80 |
| Spot Pond taken from Malden, Medford and Melrose, | — | 1,240,229 62 |
| Waban Hill Reservoir purchased from Newton, | — | 60,000 00 |
| Expenses: — | | |
| Engineering, | \$22,617 52 | |
| Conveyancing, | 3,862 92 | |
| Legal, expert and court, | 46,648 03 | |
| | | 73,128 47 |
| Deduct following, transferred and charged to special works: — | | |
| Reimbursement city of Boston, transferred to Sudbury Reservoir, | \$1,157,921 59 | |
| Waban Hill Reservoir transferred to Distribution Department, | 60,000 00 | |
| Stock — pipes, engines, etc., included with Boston Water Works and transferred to Distribution Department, | 22,340 91 | |
| | | 1,240,262 50 |
| Total for construction and acquisition of works, | \$502,624 92 | \$41,546,929 56 |

¹ Of the total expenditures from the beginning of the work, the sum of \$150,939.89 is for Clinton sewerage system.

MAINTENANCE AND OPERATION.

For the Year ending
December 31, 1910.

| | | |
|--|--------------|-------------|
| Administration, | | \$13,533 81 |
| General supervision, | | 31,296 03 |
| Taxes and other expenses, | | 36,030 04 |
| Wachusett Reservoir Department:— | | |
| Superintendence, | \$9,615 88 | |
| Reservoir, | 4,037 59 | |
| Forestry, | 6,718 58 | |
| Protection of supply, | 2,465 86 | |
| Buildings and grounds, | 2,863 21 | |
| Wachusett Dam, | 4,902 00 | |
| Wachusett Aqueduct, | 2,024 47 | |
| Clinton sewerage system:— | | |
| Pumping station, | 3,576 88 | |
| Sewers, screens and filter-beds, | 11,174 31 | |
| Sanitary inspection, | 2,519 60 | |
| Swamp drainage, | 2,315 65 | |
| | | 52,214 03 |
| Sudbury Department:— | | |
| Superintendence, Framingham office, | \$8,058 23 | |
| Ashland Reservoir, | 1,272 74 | |
| Hopkinton Reservoir, | 1,734 87 | |
| Whitehall Reservoir, | 466 60 | |
| Framingham Reservoirs Nos. 1, 2 and 3, | 6,261 02 | |
| Sudbury Reservoir, | 6,034 22 | |
| Lake Cochituate, | 7,160 87 | |
| Marlborough Brook filters, | 2,462 87 | |
| Pegan filters, | 2,913 20 | |
| Sudbury and Cochituate watersheds, | 858 48 | |
| Sanitary inspection, | 3,467 92 | |
| Cochituate Aqueduct, | 4,026 23 | |
| Sudbury Aqueduct, | 6,636 98 | |
| Weston Aqueduct, | 4,387 92 | |
| Improving Lake Cochituate, | 26,459 54 | |
| | | 82,201 69 |
| Distribution Department:— | | |
| Superintendence, | \$4,256 54 | |
| Arlington pumping station, pumping service, | 7,350 04 | |
| Chestnut Hill low-service pumping station, pumping service, | 31,487 05 | |
| Chestnut Hill high-service pumping station, pumping service, | 42,136 74 | |
| Spot Pond pumping station, pumping service, | 13,834 71 | |
| West Roxbury pumping station, pumping service, | 6,352 79 | |
| Arlington standpipe, | 29 25 | |
| Bear Hill Reservoir, | 134 58 | |
| Chestnut Hill Reservoir and grounds, | 10,292 59 | |
| Fells Reservoir, | 597 40 | |
| Forbes Hill Reservoir, | 1,033 52 | |
| Mystic Lake, conduit and pumping station, | 1,260 82 | |
| Mystic Reservoir, | 944 43 | |
| Waban Hill Reservoir, | 340 25 | |
| <i>Amounts carried forward,</i> | \$120,080 71 | \$215,275 6 |

| MAINTENANCE AND OPERATION. | For the Year ending December 31, 1910. |
|---|---|
| <i>Amounts brought forward,</i> | \$120,080 71 \$215,275 60 |
| Distribution Department — <i>Concluded.</i> | |
| Weston Reservoir, | 2,347 19 |
| Spot Pond, | 7,219 36 |
| Buildings at Spot Pond, | 123 00 |
| Pipe lines:— | |
| Low service, | 46,149 17 |
| Northern high service, | 2,647 13 |
| Southern high service, | 4,336 02 |
| Supply pipe lines, | 559 37 |
| Buildings at Chestnut Hill Reservoir, | 493 30 |
| Chestnut Hill pipe yard, | 1,054 33 |
| Glenwood pipe yard and buildings, | 4,033 83 |
| Stables, | 6,361 54 |
| Venturi meters, | 1,635 11 |
| Measurement of water, | 1,448 93 |
| Arlington pumping station, buildings and grounds, | 356 93 |
| | 198,845 92 |
| Total for maintaining and operating works, | \$414,121 52 |

(7) DETAILED FINANCIAL STATEMENT UNDER METROPOLITAN WATER ACT.

The Board herewith presents, in accordance with the requirements of the Metropolitan Water Act, a detailed statement of the expenditures and disbursements, receipts, assets and liabilities for the year 1910.

(a) Expenditures and Disbursements.

The total amount of the expenditures and disbursements on account of construction and acquisition of works for the year beginning January 1, 1910, and ending December 31, 1910, is \$502,624.92, and the total amount from the time of the organization of the Metropolitan Water Board, July 19, 1895, to December 31, 1910, is \$41,546,929.56.

For maintenance and operation the expenditures for the year have been \$414,121.52, and from the beginning of the work, \$4,225,168.78.

The salaries of the commissioners, and other expenses of administration, have been apportioned to the construction of the works and to the maintenance and operation of the same, and appear under each of those headings.

The following is a division of the expenditures according to their general character:—

| GENERAL CHARACTER OF EXPENDITURES. | For the Year ending December 31, 1910. | From Beginning of Work to December 31, 1910. |
|---|---|---|
| CONSTRUCTION OF WORKS AND ACQUISITION BY PURCHASE OR TAKING. | | |
| <i>Administration.</i> | | |
| Commissioners, | \$2,333 34 | \$120,810 25 |
| Secretary and auditor, | 750 00 | 50,592 03 |
| Clerks and stenographers, | 1,658 68 | 62,632 84 |
| Legal services, | - | 2,359 00 |
| Traveling, | 13 68 | 3,674 57 |
| Stationery and printing, | 1,512 85 | 13,248 02 |
| Postage, express and telegrams, | - | 2,917 17 |
| Furniture and fixtures, | 5 50 | 4,288 64 |
| Alterations and repairs of buildings, | 80 | 5,790 97 |
| Telephone, lighting, heating, water and care of building, | 232 26 | 11,029 34 |
| Rent and taxes, main office, | 438 59 | 5,621 49 |
| Miscellaneous expenses, | 54 08 | 4,588 75 |
| | \$6,999 78 | \$288,453 07 |
| <i>Engineering.</i> | | |
| Chief engineer and department engineers, | - | \$207,471 36 |
| Principal assistant engineers, | \$3,102 88 | 161,114 18 |
| Engineering assistants, | 7,978 67 | 1,045,992 89 |
| Consulting engineers, | 1,200 00 | 25,615 07 |
| Inspectors, | 7,710 54 | 303,471 05 |
| Architects, | - | 36,161 19 |
| Railroad and street car travel, | 694 51 | 27,579 13 |
| Wagon hire, | - | 45,337 53 |
| Stationery and printing, | 334 21 | 26,753 08 |
| Postage, express and telegrams, | - | 7,730 00 |
| Engineering and drafting instruments and tools, | - | 19,309 53 |
| Engineering and drafting supplies, | 29 23 | 25,019 51 |
| Books, maps and photographic supplies, | 60 71 | 7,049 93 |
| Furniture and fixtures, | - | 14,978 46 |
| Alterations and repairs of buildings:— | | |
| Main office, | 34 | 14,109 30 |
| Sub-offices, | - | 2,939 36 |
| Telephone, lighting, heating, water and care of buildings:— | | |
| Main office, | 696 81 | 26,454 47 |
| Sub-offices, | - | 19,667 82 |
| Rent and taxes, main office, | 1,315 80 | 16,632 95 |
| Rent of sub-offices and other buildings, | - | 4,526 74 |
| Field offices and sheds, | - | 1,274 49 |
| Clinton office building, | - | 9,866 87 |
| Unclassified supplies, | 13 65 | 8,264 87 |
| Miscellaneous expenses, | 47 76 | 8,992 75 |
| | 23,185 11 | 2,066,312 53 |
| <i>Amounts carried forward,</i> | \$30,184 89 | \$2,354,765 60 |

METROPOLITAN WATER

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| GENERAL CHARACTER OF EXPENDITURES. | For the Year ending December 31, 1910. | From Beginning of Work to December 31, 1910. |
|---|---|---|
| <i>Amounts brought forward,</i> | \$30,184 89 | \$2,354,765 60 |
| <i>Construction.</i> | | |
| Preliminary work (borings, test pits and other investigations):— | \$202 98 | \$6,661 89 |
| Advertising, | — | 155,457 41 |
| Other preliminary work as given in detail in preceding annual report, | 202 98 | 162,119 30 |
| Contracts, Wachusett Reservoir:— | | |
| Contracts completed and final payments made prior to January 1, 1910, | — | \$5,406,738 30 |
| McBride & Co., Stillwater improvement, | — | 23,314 67 |
| Sundry bills paid under this contract, | — | 3,552 11 |
| | | 5,433,605 08 |
| Contracts completed, improving Wachusett Water-shed, | — | 11,893 75 |
| Contracts completed, Wachusett Aqueduct, | — | 1,447,208 55 |
| Contracts completed, Sudbury Reservoir, | — | 1,545,028 33 |
| Contracts completed, protection Sudbury supply, | — | 9,000 00 |
| Contracts completed, improving Lake Cochituate, | — | 60,657 45 |
| Contracts completed, protection Cochituate supply, | — | 9,000 00 |
| Contracts completed, Rosemary siphon, | — | 5,916 96 |
| Contracts completed, pipe line, Dam No. 3 to Dam No. 1, | — | 17,240 22 |
| Contracts completed, Clinton sewerage system, | — | 66,878 22 |
| Contracts, Weston Aqueduct:— | | |
| Contracts completed and final payments made prior to January 1, 1910, | — | 2,376,004 54 |
| Contracts, Distribution System:— | | |
| Contracts completed and final payments made prior to January 1, 1910, | — | \$4,659,060 73 |
| Coffin Valve Co., water valves, | \$8,607 00 | 8,607 00 |
| Florence Iron Works, 60-inch cast-iron water pipes, | 62,086 55 | 100,549 39 |
| Standard Cast Iron Pipe and Foundry Co., special castings, | 5,361 45 | 8,757 20 |
| Standard Cast Iron Pipe and Foundry Co., special castings, | 5,767 10 | 5,767 10 |
| U. S. Cast Iron Pipe and Foundry Co., cast-iron pipes and special castings, | 41,998 92 | 100,603 19 |
| U. S. Cast Iron Pipe and Foundry Co., cast-iron pipes and special castings, | 4,444 71 | 4,444 71 |
| U. S. Cast Iron Pipe and Foundry Co., cast-iron water pipes, | 5,249 07 | 5,249 07 |
| <i>Amounts carried forward,</i> | \$133,514 80 | \$30,387 87 |
| | | \$4,893,038 39 |
| | | \$13,499,318 00 |

| GENERAL CHARACTER OF EXPENDITURES. | For the Year ending December 31, 1910. | From Beginning of Work to December 31, 1910. |
|---|---|---|
| <i>Amounts brought forward,</i> | \$133,514 80 | \$30,387 87 |
| <i>Construction — Con.</i> | | |
| Contracts, Distribution System — <i>Concluded.</i> | | |
| U. S. Cast Iron Pipe and Foundry Co., cast-iron water pipes, | 36,831 30 | 36,831 30 |
| U. S. Cast Iron Pipe and Foundry Co., cast-iron pipes and special castings, | 3,932 64 | 3,932 64 |
| Warren Foundry and Machine Co., cast-iron pipes and special castings, | 4,769 04 | 4,769 04 |
| Warren Foundry and Machine Co., cast-iron pipes and special castings, | 2,191 18 | 2,191 18 |
| Camoia & Williams, laying water pipes on Sect. 33, Chas. M. Callahan, laying water pipes on Sect. 35 of northern extra high-service pipe lines, | 1,787 20 | 14,231 98 |
| Devincenzi & Baruffoldi, laying water pipes on Sect. 36 of northern extra high-service pipe lines, | 4,292 38 | 4,292 38 |
| Chas. J. Jacobs Co., laying water pipes on Sect. 8 of Weston Aqueduct supply mains, | 3,233 31 | 3,233 31 |
| Joseph Hanreddy, laying water pipes on Sect. 7 of Weston Aqueduct supply mains, | 19,546 64 | 40,525 39 |
| Cavanagh Bros., laying water pipes on Sect. 6 of Weston Aqueduct supply mains, | 52,300 19 | 52,300 19 |
| Michael Russo, laying water pipes on Sect. 37 of low-service pipe lines, | 36,661 10 | 36,661 10 |
| Holly Manufacturing Co., furnishing and erecting pumping engine at the Chestnut Hill high-service pumping station, | 11,823 18 | 11,823 18 |
| Standard Cast Iron Pipe and Foundry Co., cast-iron pipes and special castings, | 50,000 00 | 50,000 00 |
| | 3,609 61 | 3,609 61 |
| | 364,492 57 | |
| Deduct value of pipes, valves, etc., included in above list, transferred to maintenance account December 31, 1900, | | \$5,157,439 69 |
| | | 3,139 77 |
| | | 5,154,299 92 |
| <i>Additional work:—</i> | | |
| Labor, | \$28,205 07 | \$796,606 72 |
| Professional services, medical services, analyses, etc., | 1,698 00 | 3,680 99 |
| Traveling, | 70 | 2,747 80 |
| Rent, | 375 00 | 4,077 22 |
| Water rates, | — | 1,454 77 |
| Freight and express, | 393 25 | 13,862 57 |
| Jobbing and repairing, | 247 90 | 9,946 08 |
| Tools, machinery, appliances and hardware supplies, | 5,905 72 | 84,243 97 |
| Electrical supplies, | 185 30 | 5,563 93 |
| <i>Amounts carried forward,</i> | \$37,010 94 | \$394,880 44 |
| | | \$922,184 05 |
| | | \$18,653,617 92 |

| GENERAL CHARACTER OF EXPENDITURES. | For the Year ending December 31, 1910. | From Beginning of Work to December 31, 1910. |
|---|---|---|
| <i>Amounts brought forward,</i> | \$37,010 94 \$394,880 44 | \$922,184 05 \$18,653,617 92 |
| <i>Construction — Con.</i> | | |
| Additional work — <i>Con.</i> | | |
| Castings, ironwork and metals, | 3,552 99 | 87,259 03 |
| Iron pipe and valves, | 13,709 23 | 75,762 40 |
| Blasting supplies, | 5 27 | 1,950 15 |
| Paint and coating, | 125 93 | 4,599 46 |
| Fuel, oil and waste, | 1,624 82 | 12,178 12 |
| Lumber and field buildings, | 2,817 10 | 90,011 88 |
| Drain pipe, | 72 00 | 9,235 80 |
| Brick, cement and stone, | 4,439 23 | 31,497 95 |
| Sand, gravel and filling, | 663 69 | 7,603 35 |
| Municipal and corporation work, | 5,592 68 | 220,664 67 |
| Police service, | — | 210,801 74 |
| Sanitary inspection, | — | 13,107 09 |
| Judgments and settlements for damages, | — | 53,124 26 |
| Unclassified supplies, | 266 78 | 17,978 30 |
| Miscellaneous expenses, | 85 78 | 6,154 25 |
| | 69,966 44 | 1,764,112 50 |
| <i>Legal and expert: —</i> | | |
| Legal services, | — | \$4,668 82 |
| Expert services, | — | 1,862 66 |
| Court expenses, | — | 1,317 20 |
| Miscellaneous expenses, | — | 185 80 |
| | | 8,034 48 |
| <i>Real Estate.</i> | | |
| <i>Legal and expert: —</i> | | |
| Legal services, | — | \$4,736 31 |
| Conveyancer and assistants, | \$262 00 | 110,644 97 |
| Experts, | 137 35 | 18,008 93 |
| Appraisers, | — | 22,332 75 |
| Court expenses, | — | 11,139 43 |
| Counsel expenses, | — | 43 25 |
| Conveyancing supplies, | 6 00 | 3,190 53 |
| Conveyancing expenses, | 40 40 | 5,977 94 |
| Miscellaneous expenses, | — | 4,326 15 |
| Settlements made by Board, | 37,052 23 | 3,428,365 07 |
| Judgments, | 270 61 | 170,716 24 |
| Taxes and tax equivalents, | — | 68,182 41 |
| Care and disposal, | 9 45 | 86,901 14 |
| | 37,778 04 | 3,934,565 12 |
| <i>Damages to Real Estate not taken, to Business and on Account of Loss of Wages.</i> | | |
| <i>Legal and expert: —</i> | | |
| Legal services, | — | \$1,130 67 |
| Expert services, | — | 2,857 62 |
| Court expenses, | — | 15,394 34 |
| <i>Amounts carried forward,</i> | — | \$19,382 63 \$24,360,330 02 |

| GENERAL CHARACTER OF EXPENDITURES. | For the Year ending December 31, 1910. | From Beginning of Work to December 31, 1910. |
|---|---|---|
| <i>Amounts brought forward,</i> | - \$502,624 92 | \$19,382 63 \$24,360,330 02 |
| <i>Damages to Real Estate not taken, to Business and on Account of Loss of Wages — Con.</i> | | |
| Legal and expert — Con. | | |
| Miscellaneous expenses, | - | 125 00 |
| Settlements, | - | 415,513 65 |
| Judgments, | - | 116,733 42 |
| | | 551,754 70 |
| <i>Claims on Account of Diversion of Water.</i> | | |
| Legal and expert: — | | |
| Legal services, | - | \$3,774 98 |
| Expert services, | - | 19,339 69 |
| Court expenses, | - | 20,775 49 |
| Miscellaneous expenses, | - | 1,289 58 |
| Settlements, | - | 917,350 00 |
| Judgments, | - | 220,969 67 |
| | | 1,183,499 41 |
| <i>Purchase of Existing Water Works.</i> | | |
| Legal and expert: — | | |
| Legal services, | - | \$1,878 89 |
| Expert services, | - | 13,569 82 |
| Court expenses, | - | 29,728 38 |
| Miscellaneous expenses, | - | 1,470 94 |
| Settlements and judgments, | - | 15,227,100 01 |
| | | 15,273,748 04 |
| <i>Relocation Central Massachusetts Railroad.</i> | | |
| Settlements, | - | 177,597 39 |
| Total amount of construction expenditures, | \$502,624 92 | \$41,546,929 56 |

| GENERAL CHARACTER OF EXPENDITURES. | For the Year ending December 31, 1910. |
|--|---|
| MAINTENANCE AND OPERATION OF WORKS. | |
| Administration: — | |
| Commissioners, | \$5,833 33 |
| Secretary and assistants, | 6,173 66 |
| Rent, | 333 32 |
| Repairs of building, | 204 52 |
| Fuel, | 19 73 |
| Lighting, | 82 93 |
| Care of building, | 389 01 |
| Postage, | 36 00 |
| <i>Amount carried forward,</i> | \$13,072 50 |

| GENERAL CHARACTER OF EXPENDITURES. | For the Year ending December 31, 1910. |
|--|---|
| <i>Amount brought forward,</i> | \$13,072 50 |
| MAINTENANCE AND OPERATION OF WORKS — <i>Con.</i> | |
| Administration — <i>Con.</i> | |
| Printing, stationery and office supplies, | 409 12 |
| Telephones, | 217 18 |
| Traveling expenses, | 55 27 |
| Miscellaneous expenses, | 37 74 |
| | <hr/> |
| | \$13,791 81 |
| General supervision:— | |
| Chief engineer and assistants, | \$24,975 63 |
| Rent, | 1,000 00 |
| Repairs of building, | 833 34 |
| Fuel, | 59 18 |
| Lighting, | 250 75 |
| Care of building, | 1,167 20 |
| Postage, | 119 00 |
| Printing, stationery and office supplies, | 814 55 |
| Telephones, | 740 09 |
| Traveling expenses, | 409 55 |
| Miscellaneous expenses, | 926 74 |
| | <hr/> |
| | 31,296 03 |
| Pumping service:— | |
| Labor, | \$61,933 82 |
| Fuel, | 34,332 78 |
| Oil, waste and packing, | 1,398 44 |
| Repairs, | 1,465 59 |
| Small supplies, | 1,274 17 |
| Rent, West Roxbury pumping station, | 786 53 |
| | <hr/> |
| Reservoirs, aqueducts, pipe lines, buildings and grounds:— | 101,191 33 |
| Superintendents, | \$6,600 00 |
| Engineering assistants, | 9,259 65 |
| Sanitary inspectors, | 3,651 65 |
| Labor, pay roll, | 125,580 59 |
| Labor, miscellaneous, | 1,831 92 |
| Alterations and repairs of pumping stations, | 79 91 |
| Alterations and repairs of other buildings and structures, | 792 70 |
| Automobiles, | 4,850 66 |
| Brick, | 65 50 |
| Brooms, brushes and janitor's supplies, | 144 79 |
| Castings, ironwork and metals, | 955 65 |
| Cement and lime, | 489 02 |
| Drafting and photo supplies, | 100 12 |
| Fertilizer and planting material, | 455 96 |
| Freight and express, | 510 51 |
| Fuel, | 3,257 89 |
| <i>Amounts carried forward,</i> | \$158,626 52 \$146,279 17 |

| GENERAL CHARACTER OF EXPENDITURES. | For the Year ending December 31, 1910. |
|--|---|
| <i>Amounts brought forward,</i> | \$158,626 52 \$146,279 17 |
| MAINTENANCE AND OPERATION OF WORKS — Con. | |
| Reservoirs, aqueducts, pipe lines, buildings and grounds — Con. | |
| Gypsy moth supplies, | 684 46 |
| Hardware, | 709 84 |
| Hay and grain, | 2,113 86 |
| Horses, | 543 50 |
| Lighting, | 393 97 |
| Lumber, | 1,738 73 |
| Machinery, | 67 10 |
| Paints and oils, | 1,077 63 |
| Pipe and fittings, | 11,080 99 |
| Postage, | 124 73 |
| Printing, stationery and office supplies, | 647 98 |
| Rubber and oiled goods, | 319 60 |
| Stable expenses, | 844 90 |
| Sand, gravel and stone, | 84 46 |
| Traveling expenses, | 2,286 54 |
| Telephones, | 930 41 |
| Teaming, | 1,202 25 |
| Tools and appliances, | 958 28 |
| Vehicles, harnesses and fittings, | 409 09 |
| Municipal and corporation work, | 135 83 |
| Miscellaneous expenses, | 21,377 55 |
| Contracts: — | |
| Henry Spinach Contracting Co., contract 19-M, improvement of Lake Cochituate (surface-water drains in Framingham, Natick and Wayland), | 25,712 09 |
| Payments in lieu of taxes, | 232,070 31 |
| Total expenditures for maintenance and operation, | 35,772 04 |
| | \$144,121 52 |

(b) Receipts.

The total amount of receipts from the operations of the Board and from sales of property for the year beginning January 1, 1910, and ending December 31, 1910, is \$62,379.24, and the total amount from the time of the organization of the Metropolitan Water Board, July 19, 1895, to December 31, 1910, is \$714,973.06. The general character of these receipts is as follows: —

METROPOLITAN WATER

[Pub. Doc.]

| GENERAL CHARACTER OF RECEIPTS. | For the Year ending December 31, 1910. | From Beginning of Work to December 31, 1910. |
|--|---|---|
| For distribution back to District:— | | |
| Fees for admission to District, | — | \$92,265 00 |
| Water furnished to cities and towns outside of District, | — | 90,454 77 |
| Water furnished to water companies, | — | 37,145 88 |
| | — | — |
| | | \$219,865 65 |
| To the credit of the loan fund:— | | |
| Real estate and buildings, | \$5,991 32 | \$44,039 34 |
| Tools, supplies and reimbursements, | 25,511 06 | 154,534 70 |
| District entrance fees (Swampscott), | — | 90,000 00 |
| | — | — |
| | \$31,502 38 | 258,574 04 |
| To the credit of the maintenance fund:— | | |
| Tools, supplies and reimbursements, | \$19,550 33 | \$26,776 07 |
| | — | — |
| | 19,550 33 | 26,776 07 |
| To the credit of the sinking fund:— | | |
| Water furnished to cities and towns outside of District and to water companies, | \$3,947 54 | \$20,798 75 |
| Forfeiture for contracts awarded but not exe- cuted, | — | 500 00 |
| Rents, | 1,633 41 | 94,072 78 |
| Land products, | 5,544 58 | 60,926 86 |
| Unclassified receipts and interest, | 201 00 | 3,458 91 |
| | — | — |
| | 11,326 53 | 179,757 30 |
| Total receipts, | \$62,379 24 | \$714,973 06 |

The foregoing receipts have been credited to the various objects or works, as follows:—

| SOURCES OF RECEIPTS. | For the Year ending December 31, 1910. | From Beginning of Work to December 31, 1910. |
|---|---|---|
| Admission into Metropolitan Water District (Quincy, Nahant, Arlington, Stoneham, Milton, Lexington and Swampscott), | — | \$182,265 00 |
| Supplying water to cities and towns outside of Water District (Swampscott, Revere, Lexington, Wakefield, Cambridge, Framingham and U. S. Government), and to water companies (Framingham, Milton and Revere), | \$3,947 54 | 148,399 40 |
| | — | — |
| | \$3,947 54 | — |
| | | \$330,664 40 |
| Construction and acquisition of works:— | | |
| Administration, | \$41 11 | \$285 06 |
| Wachusett Dam, | 152 77 | 6,912 25 |
| | — | — |
| Amounts carried forward, | \$193 88 | \$7,197 31 |
| | \$3,947 54 | \$330,664 40 |

| SOURCES OF RECEIPTS. | For the Year ending December 31, 1910. | | From Beginning of Work to December 31, 1910. | |
|--|---|-------------|---|--------------|
| <i>Amounts brought forward,</i> | \$193 88 | \$3,947 54 | \$7,197 31 | \$330,664 40 |
| Construction and acquisition of works— <i>Con.</i> | | | | |
| Wachusett Reservoir, | 4,367 30 | | 140,042 17 | |
| Wachusett Aqueduct, | | — | 5,204 70 | |
| Weston Aqueduct, | 62 50 | | 5,200 13 | |
| Sudbury Reservoir, | 25 00 | | 10,640 42 | |
| Distribution system, | 26,982 31 | | 101,340 59 | |
| Diversion of water, Clinton sewerage system, | — | | 1,367 94 | |
| Purchase of existing water works, | — | | 18,119 08 | |
| | | 31,630 99 | | 289,112 34 |
| Maintenance and operation of works:— | | | | |
| Administration, | \$102 83 | | \$221 39 | |
| General supervision, | 450 00 | | 1,252 76 | |
| Wachusett Aqueduct, | 293 71 | | 4,973 78 | |
| Wachusett Reservoir, | 5,132 10 | | 33,118 67 | |
| Sudbury system, | 2,221 09 | | 17,684 47 | |
| Distribution system, | 18,136 93 | | 32,602 46 | |
| Clinton sewerage system, | 464 05 | | 5,342 79 | |
| | | 26,800 71 | | 95,196 32 |
| Total receipts, | | \$62,379 24 | | \$714,973 06 |

(c) Assets.

The following is an abstract of the assets of the Water Works, a complete schedule of which is kept on file in the office of the Board:—

Office furniture, fixtures and supplies; engineering and scientific instruments and supplies; police supplies; horses, vehicles, field machinery, etc.; machinery, tools and other appliances and supplies; real estate connected with works not completed; completed works, including real estate and buildings connected therewith.

(d) Liabilities.

The sums due on monthly pay rolls amount to \$1,594.72, and there are bills for current expenses which have not yet been received.

Amounts on Monthly Estimates, not due until Completion of Contracts or until Claims are settled.

| NAME. | Work. | Amount. |
|--|--|-----------------------|
| McBride & Co., | Contract 233, Stillwater improvement, Wa-chusett Reservoir. | \$778 09 ¹ |
| Camoia & Williams, | Contract 308, Section 33 of northern high-service pipe lines, Distribution System. | 689 29 |
| Chas. M. Callahan, | Contract 316, Section 35 of northern high-service pipe lines, Distribution System. | 225 92 |
| Devincenzi & Baruffoldi, | Contract 322, Section 36 of northern extra high-service pipe lines, Distribution System. | 100 00 |
| Joseph Hanreddy, | Contract 314, Section 7 of the Weston Aque-duct supply mains. | 9,052 97 |
| Cavanagh Bros., | Contract 323, Section 6 of the Weston Aque-duct supply mains. | 4,116 67 |
| Michael Russo, | Contract 326, Section 37 of low-service pipe lines, Distribution System. | 1,262 92 |
| Standard Cast Iron Pipe and Foundry Company. | Contract 325, cast-iron pipes and special castings. | 636 99 |
| The Henry Spinach Contracting Company, | Contract 19-M, improving Lake Cochituate, . | 4,537 43 |
| Holly Manufacturing Company, | Contract 312, pumping engine for Chestnut Hill low-service pumping station. | 49,769 00 |

¹ Held pending settlement of claims on account of this contract.

It is impossible to state the amounts due on the claims of the following for land damages, for water rights taken and for damages to established business, as no sums have been agreed upon, and suits are now pending in court for the determination of most of them:—

Patrick Bradley, Henry F. Keyes, James E. Welch, Byron D. Allen, J. Frank Wood *et al.*, Asa Knight, Edward F. Merriam, Sanford C. Kendall, estate of William H. Vickery, James H. and Hannah S. Wood, Francis W. M. Goodale, heirs of Willard Morse, Caroline R. Braman, Charles G. Rice, Nehemiah W. Rice *et al.*, John Ward *et al.*, heirs of George K. Ward, heirs of Francis Pettee, William F. Harbach *et al.*, Fannie M. Flemming, Royal S. Went-worth *et al.*, trustees.

VI. METROPOLITAN SEWERAGE WORKS.

The North Metropolitan Sewerage District embraces the cities of Cambridge, Chelsea, Everett, Malden, Medford, Melrose, Somerville and Woburn, and the towns of Arlington, Belmont, Revere, Stoneham, Wakefield, Winchester and Winthrop, and parts of the city of Boston and the town of Lexington,—comprising in all 9 cities and 8 towns. The district has an area of 90.50 square miles, with an estimated population, based upon the United States Census of 1910, as of December 31, 1910, of 534,217. Of the total popu-

lation it is estimated that 87.1 per cent., or 465,302 people, contribute sewage to the North Metropolitan System. The sum of \$209,065.54 has been expended on account of construction during the past year. The total cost of the North Metropolitan Sewerage Works has been \$6,521,196.15.

The South Metropolitan Sewerage District includes the cities of Newton, Quincy and Waltham, and the towns of Brookline, Hyde Park, Milton and Watertown, and parts of the city of Boston and the town of Dedham,— a total of 4 cities and 5 towns. This district has an area of 100.87 square miles, with an estimated population as of December 31, 1910, of 359,670. According to the estimates made 64 per cent. of this population, or 230,365, contribute sewage to the South Metropolitan System. The sum of \$7,481.84 has been expended on account of construction during the past year. The total expenditures for construction of the South Metropolitan Sewerage Works have amounted to \$8,792,779.64.

Chapter 546 of the Acts of the Legislature of 1910 added the territory comprising the town of Braintree to the South Metropolitan District. This Act, however, was to take effect only when accepted by a majority of the legal voters of the town of Braintree present and voting thereon at a meeting legally called for the purpose. No action under the Act was taken by the town during the year.

(1) NORTH METROPOLITAN SEWERAGE SYSTEM — CONSTRUCTION.

(a) *Deer Island Pumping Station Extension.*

The work of extending the Deer Island pumping station and of installing a new pumping engine, with boilers and other apparatus, has been continued during the year and brought substantially to completion. The addition to the pumping station was 50 feet long and 45 feet, 8 inches wide, and there has been added a new coal house having a length of 103 feet and a width of 35 feet. These buildings have been erected so as to harmonize in general with the old station. There has been installed in the house a new pumping engine constructed by the Allis-Chalmers Company, having a capacity for pumping 100,000,000 gallons of sewage per day, with a lift of 19 feet. The engine was put into operation in the month of April. The operation of the engine and pumps in the ordinary working service of the station has been satisfactory, and the test which has been made has shown an efficiency and duty considerably in advance

of the stipulations made in the contract. The sum of \$177,707.76 has been expended, \$101,631.68 in connection with the building and \$76,076.08 for the pumping plant. The entire expense will come within the original appropriation of \$195,000.

(b) *East Boston Pumping Station Extension.*

Work has been continued during the year in completing the repairs to the East Boston pumping station, which was partially burned at the Chelsea fire, and in erecting the additions to the station and new coal house which had been contemplated. A pile wharf has been built in connection with the coal house, and this is to be made so far as possible fireproof. The parts of the new pumping engine to be furnished by the Allis-Chalmers Company have been delivered and are now in process of being set up. Boilers and other accessories have already been erected, and it is expected that the engine will be in condition to be put into operation in the first half of the coming year. The sum of \$160,175.85 has been expended on account of the extensions and pumping plant at this station. The cost of the repairs and renewals of the East Boston station, made necessary on account of the Chelsea fire, which will be chargeable to maintenance, has amounted to \$39,150.57, leaving a small balance from the total special appropriation of \$40,000.

(c) *East Boston Stable and Locker Building.*

A beginning has been made in the erection of a building for stable and locker purposes on the lot between Chelsea Street and the Grand Junction Railroad, near the East Boston pumping station, recently purchased in place of the old stable and locker lot, and the structure has been about half completed. The building and grounds will be made ready for occupancy during the coming season.

(2) SOUTH METROPOLITAN SEWERAGE SYSTEM — CONSTRUCTION.

Quincy Sewage Lift.

In accordance with the requirement of the original High-level Sewer Act, that the Metropolitan Sewerage Commission should build and operate such force mains and pumping stations as might be necessary to drain the sewerage system of the city of Quincy into the High-level Sewer, the Board was called upon by that city to provide

for the lifting of the sewage of the low district, comprising the easterly and southerly portions of Hough's Neck, into the main sewer.

The Board has, therefore, under the authority of chapter 292 of the Acts of 1910, proceeded to the erection of a small building on Island Avenue, about half a mile distant from the Nut Island screen-house, near which is built a storage well, and in which is also installed an automatic lift, to be operated by electricity generated at the Nut Island screen-house, from which the working of the lift is regulated. Two pumps, having each a daily capacity of 1,500,000 gallons, have been installed. The lift will be ready for operation early in the coming year.

(3) ACQUISITION OF LAND AND SETTLEMENTS.

The Board acquired during the year, by purchase, about 9,708 square feet of land on Chelsea Street and Chelsea Creek in East Boston, near the East Boston sewerage pumping station, for the purposes of a stable and locker building, for which the sum of \$4,463.40 was paid. A taking also of the parcel was afterwards made.

A settlement was also effected for an easement in 0.019 of an acre of land in Brookline, previously taken for the construction of the High-level Sewer, in which the sum of \$192.87 was paid.

Taking for Metropolitan Sewerage Works for the Year 1910.

| No. | LOCATION AND DESCRIPTION. | Former Owner. | Re- corded. | Purpose of Taking. |
|-----|--|----------------------|-------------------|---------------------------------|
| 24 | East Boston, — on Addison Street and Boston & Albany Railroad. Area, fee in 9,708 square feet. Also rights of way in street and railroad location. | East Boston Company. | 1910. Apr. 22. | For stable and locker building. |

(4) NORTH METROPOLITAN SYSTEM — MAINTENANCE.

The cost of maintenance of the North Metropolitan System during the past year has been \$148,991. In addition to this, \$11,760 was expended in the repairs on the East Boston station from the special appropriation of \$40,000.

(a) Sewers and Pumping Stations.

The length of the sewers on the North Metropolitan System is 58.57 miles, and the Metropolitan sewers with connections with local

sewers have a combined length of 669.07 miles, involving 69,443 connections.

The sewage before it is finally disposed of in the harbor off Deer Island is lifted, the most of it at least twice and a portion three times, by pumping at the four stations, the Alewife Brook, Charlestown, East Boston and Deer Island pumping stations.

The daily average amount of sewage discharged into the harbor from the Deer Island outlet was 59,000,000 gallons, which was a daily average for each individual of the population contributing sewage of 126.8 gallons. This daily average is made larger from the fact that a considerable number of the local sewers permit the direct introduction of rain water. The total amount of the discharge is 1,600,000 gallons per day less than that of the preceding year, a decrease which is accounted for by the scarcity of the rainfall. The maximum amount of sewage discharged in any one day in the year was 135,100,000 gallons.

The pumping stations operated for the North Metropolitan Sewerage System are as follows:—

| | No. of Engines. | Maximum Contract Capacity per Day (Gallons). | Lift (Feet). |
|-----------------------------------|-----------------|--|--------------|
| Deer Island Station, | 4 | 300,000,000 | 19 |
| East Boston Station, ¹ | 3 | 165,000,000 | 19 |
| Charlestown Station, | 3 | 160,000,000 | 11 8 |
| Alewife Brook Station, | 3 | 23,000,000 | 13 |

¹ The new pumping engine in process of erection for the East Boston pumping station will have a maximum contract capacity of 100,000,000 gallons, and a lift of 19 feet.

There were consumed for the operation of the pumping stations 7,329.21 tons of bituminous coal, which was purchased at average prices at the different stations varying from \$3.72 to \$4.38 per gross ton delivered in the bins.

The sums expended for the labor of engineers and their assistants in the various pumping stations of the district amounted to \$55,754.93.

The average cost per million gallons of sewage per foot lifted at the several stations was \$0.122.

(b) Siphons and Relocation of Sewers.

The siphons which were required to be introduced in the main sewer crossing the Alewife Brook in Arlington, in order to conform to the improvements made by the Metropolitan Park Commission, were substantially completed in the previous year, but were put into operation at the beginning of the past year. The cost of the changes made was \$2,634.27, and this sum was repaid by the Park Commission.

The siphon which was made necessary in the Metropolitan sewer in Cambridge, at Portland Street, by the building of the subway by the Boston Elevated Railway Company, was completed early in the year and put into operation. The introduction of this siphon requires the cleaning and flushing of the sewer as often as twice in each week by a gang of sewer men, causing a very considerable increase in the annual expenses of the District for maintenance. The construction of the subway also compelled a relocation of the Metropolitan sewer, originally built in Eliot Street and Eliot Square, by a detour into Murray Street. The old sewer was abandoned for a distance of 470 feet and its place was supplied by 660 feet of new sewer and iron pipes. By this relocation the introduction of another siphon was avoided. The necessary work involved was performed at both points by the Railway Company, at an approximate cost of \$29,000.

(c) Tanneries and Gelatine and Glue Works.

The quantity and character of the matter discharged into the Metropolitan sewers from the tanneries and the gelatine and glue works in the city of Woburn and the towns of Winchester and Stoneham have called for the serious attention of the Board.

Complaints have been made in the past of overflows from manholes occurring in some instances during periods of heavy rain, from the Mystic Valley main sewer which receives the sewage of the city of Woburn and the town of Winchester. Careful investigations have been made with the view to ascertain whether this sewer had so nearly reached the proper limit of its capacity that the time had come to call for the construction of a supplementary main sewer for this district.

Upon the construction of the North Metropolitan Sewerage Sys-

tem the lower portion of the old Mystic Valley sewer, built by the city of Boston for the protection of the Mystic water supply, was taken to form a part of the Metropolitan System. The upper portion of the old sewer running through the town of Winchester and into the city of Woburn still remained the property of the city of Boston, and was subsequently taken over by the Board in connection with the city's water works. The manufacturing establishments were still permitted to use the upper part of the old sewer, under protective restrictions, for the discharge of their sewage and wastes into the Metropolitan System.

The investigations showed that these establishments had begun to neglect the restrictions which had been long before observed, and were emptying into this sewer great quantities of objectionable manufacturing wastes which were passing down and entering the Metropolitan sewer below. The wastes were of such a glutinous character as to clog the sewers, and, in fact, seriously to diminish their actual capacities for the carrying of sewage. The proprietors of the establishments were called upon to abide by the restrictions formerly made, and to provide settling tanks which should receive and collect the objectionable substances before any discharge from the works should enter the sewer. The municipal authorities were also notified that, unless the directions of the Board were observed, discharge into the Metropolitan sewers from the offending establishments would not be permitted.

After considerable delay on the part of some of the proprietors the Board's requirements have been complied with, and except in two cases settling tanks have been built and put in operation. In the two excepted cases the tanks are in process of construction.

It is still a question, independent of the admission of objectionable waste, whether the great quantities of liquids coming from these establishments should continue to be discharged into the Metropolitan System, which was intended for the disposal of sewage only.

The measures which have been taken will much improve the situation which has been complained of, and it is possible that by the observance of proper regulations the necessity for further and expensive sewer construction for the Mystic Valley will be deferred for a considerable period.

(5) SOUTH METROPOLITAN SEWERAGE SYSTEM — MAINTENANCE.

The entire cost of maintenance during the past year has been \$101,781.68.

Sewers and Pumping Stations.

The Metropolitan sewers in the South Metropolitan System have a length of 43.42 miles, and with these are connected local sewers having a length of 542.25 miles, requiring 148 connections.

The pumping stations operated for the South Metropolitan Sewerage System are as follows:—

| | No. of Engines. | Maximum Contract Capacity per Day (Gallons). | Lift (Feet). |
|--------------------------------|-----------------|--|--------------|
| Ward Street Station, | 2 | 100,000,000 | 45 |
| Quincy Station, | 3 | 18,000,000 | 28 |

The larger part of the sewage of the District is lifted into the High-level Sewer at the Ward Street pumping station in Roxbury, but the sewage of the city of Quincy is pumped into the sewer at Greenleaf Street near the Quincy pumping station. The entire sewage is screened at the Nut Island screen-house, and thence discharged at the bottom of the harbor about a mile off from the Island.

The average daily amount of the sewage thus discharged was 39,600,000 gallons, and the largest discharge in a single day was 141,000,000 gallons. The decrease in the daily average discharge from last year was 800,000 gallons.

The daily average discharge of sewage for each individual contributing sewage in the District was 171.9 gallons. The decrease from last year of 1.47 gallons was principally owing to the lack of heavy rains.

There were 2,810.81 gross tons of bituminous coal consumed at the two pumping stations and screen-house, which was purchased at average prices varying from \$3.98 to \$4.21 per gross ton delivered in the bins.

The expenditures for the labor of the engineers and their assistants at the three stations amounted to \$31,849.69.

VII. SEWERAGE WORKS—FINANCIAL STATEMENT.

The financial abstract of the receipts, expenditures, disbursements, assets and liabilities of the Metropolitan Water and Sewerage Board for the fiscal year of the Commonwealth ending with the thirtieth day of November, 1910, was, as stated in connection with the Water Works, presented to the General Court in January, in accordance with the requirements of chapter 235 of the Acts of the year 1906 and a copy of this financial abstract is in part printed as Appendix No. 5.

The following statement of its financial doings, in relation to the Metropolitan Sewerage Works, for the calendar year 1910, is herewith presented, in accordance with the provisions of the Act of 1906, as a part of the annual report of the Board.

The Metropolitan Sewerage Loans authorized for the construction of the Sewerage Works of the North Metropolitan System have amounted to \$6,573,865.73, to which are added receipts from various sources amounting to \$63,391.78. The amount of expenditures approved by the Board for payment for the year 1910 was \$209,065.54, and the total amount of expenditures approved to January 1, 1911, was \$6,521,196.15. The balance remaining on January 1, 1911, was \$116,061.36.

The loans authorized for the construction of the various parts of the South Metropolitan System have amounted to \$8,867,046.27. The receipts applicable to the loan fund have been \$13,401.13. The amount of expenditures approved for payment in the year 1910 was \$7,481.84. The total amount of expenditures approved for payment from the beginning of the works has been \$8,792,779.64. The balance remaining for the South Metropolitan System on January 1, 1911, was \$87,667.76.

The bonds issued on account of the loans have been for varying periods, not exceeding forty years, and bear interest at the rate of 3 per cent. and $3\frac{1}{2}$ per cent. The premiums received on account of the sale of bonds for the North Metropolitan System have amounted to \$179,547.35, and those received on account of the South Metropolitan System have amounted to \$410,132.03.

The increase in the debt during the calendar year, as represented by the Metropolitan Sewerage Loans, was \$113,000. The increase of the sinking fund for the payment of the debt at maturity was,

during the same period, \$257,957.49. There has consequently been a decrease in the net debt during the calendar year amounting to \$144,957.49.

The amount expended for maintenance of the North Metropolitan System in the year 1910 was \$160,751, and for the South Metropolitan System \$101,781.68, a total for both systems of \$262,532.68.

The assessments made to meet interest, sinking fund requirements and maintenance and operation of the North Metropolitan System amounted in the year 1910 to \$442,376.41, and the assessments for the South Metropolitan System amounted to \$457,071.75.

The following is a detailed financial statement regarding the Metropolitan Sewerage Works:—

(1) METROPOLITAN SEWERAGE LOANS, RECEIPTS AND PAYMENTS.

The loans authorized for the construction of the Metropolitan Sewerage Works, the receipts which are added to the proceeds of these loans, and the expenditures for construction, have been as follows:—

(a) North Metropolitan System.

Loans authorized under the various acts, including those for the Revere, Belmont and Malden extensions and North System enlargement and extension, \$6,573,865 73

Receipts from sales of real estate and from miscellaneous sources, which are placed to the credit of the North Metropolitan System:—

| | |
|--|-----------------------|
| For the year ending December 31, 1910, | \$254 59 ¹ |
|--|-----------------------|

| | |
|--|------------------------|
| For the period prior to January 1, 1910, | 63,137 19 ¹ |
|--|------------------------|

| | |
|-------|-----------|
| ————— | 63,391 78 |
|-------|-----------|

| | |
|-------|----------------|
| ————— | \$6,637,257 51 |
|-------|----------------|

Amount approved for payment by the Board² out of the Metropolitan Sewerage Loan Fund, North System:—

| | |
|--|--------------|
| For the year ending December 31, 1910, | \$209,065 54 |
|--|--------------|

| | |
|--|--------------|
| For the period prior to January 1, 1910, | 6,312,130 61 |
|--|--------------|

| | |
|-------|--------------|
| ————— | 6,521,196 15 |
|-------|--------------|

| | |
|--|--------------|
| Balance, North Metropolitan System, January 1, 1911, | \$116,061 36 |
|--|--------------|

¹ Of these amounts (\$130.60 for the year 1910), a total of \$16,960.61 was received directly by the State Treasurer and credited to this fund and not on our books until December, 1910.

² The word "Board" refers to the Metropolitan Sewerage Commission and the Metropolitan Water and Sewerage Board.

(b) South Metropolitan System.

| | | |
|--|-------------|-------------|
| Loans authorized under the various acts, applied to the construction of the Charles River valley sewer, Neponset valley sewer, High-level sewer and extension, | \$8,867,046 | 27 |
| Receipts for pumping, sales of real estate and from miscellaneous sources, which are placed to the credit of the South Metropolitan System:— | | |
| For the year ending December 31, 1910, | 1,994 | 31 |
| For the period prior to January 1, 1910, | 11,406 | 82 |
| | | \$8,880,447 |
| | | 40 |

Amount approved by the Board¹ for payment out of the Metropolitan Sewerage Loan Fund, South System:—

| | | |
|---|-----------|-----------|
| On account of the Charles River valley sewer, | \$800,046 | 27 |
| On account of the Neponset valley sewer, | 911,531 | 46 |
| On account of the High-level sewer and extension:— | | |
| For the year ending December 31, 1910, | 7,481 | 84 |
| For the period prior to January 1, 1910, | 7,073,720 | 07 |
| | | 7,081,201 |
| | | 91 |
| | | 8,792,779 |
| | | 64 |

Balance, South Metropolitan System, January 1, 1911, \$87,667 76

(2) ISSUES OF METROPOLITAN SEWERAGE LOAN BONDS.

The Treasurer of the Commonwealth, under the authority of the successive statutes, has from time to time issued bonds designated "Metropolitan Sewerage Loan," amounting for the North System to \$6,563,000, and for the South System to \$8,877,912. The list of the bonds issued prior to the year 1910 is contained in the last (Ninth) Annual Report. The bonds issued in the year 1910 are as follows:—

¹ The word "Board" refers to the Metropolitan Sewerage Commission and the Metropolitan Water and Sewerage Board.

| DATE OF SALE. | Amount of Bonds sold. | Rate of Interest (Per Cent.). | Price received. | Date due. | Premium. |
|-----------------------|-----------------------|-------------------------------|-----------------|--------------|----------|
| Feb., 1910, | \$113,000 | 3½ | 100.39 | Jan. 1, 1950 | \$440 70 |

(3) METROPOLITAN SEWERAGE LOANS SINKING FUND.

Under the authority of chapter 122 of the Acts of the year 1899 the Treasurer and Receiver-General of the Commonwealth was required to consolidate the sinking funds of all the Metropolitan Sewerage Loans into one fund, to be known as the Metropolitan Sewerage Loans Sinking Fund.

The Board received during the year, from rentals and from other sources, to be applied to the sinking fund, \$182.19.

The sinking fund established has amounted at the end of each year to sums as follows:—

| | | | |
|----------------------|--------------|----------------------|----------------|
| December 31, 1899, . | \$361,416 59 | December 31, 1905, . | \$1,008,724 95 |
| December 31, 1900, . | 454,520 57 | December 31, 1906, . | 1,146,998 68 |
| December 31, 1901, . | 545,668 26 | December 31, 1907, . | 1,306,850 30 |
| December 31, 1902, . | 636,084 04 | December 31, 1908, . | 1,492,418 98 |
| December 31, 1903, . | 754,690 41 | December 31, 1909, . | 1,673,784 40 |
| December 31, 1904, . | 878,557 12 | December 31, 1910, . | 1,931,741 89 |

(4) ANNUAL APPROPRIATIONS, RECEIPTS AND EXPENDITURES.

The annual appropriations for the maintenance of the Metropolitan Sewerage Works, the receipts of the Board which are added to the appropriations for maintenance, and the expenditures for maintenance for the year ending December 31, 1910, have been as follows:—

| <i>North Metropolitan System.</i> | | | |
|---|--|--|-------------------------|
| Appropriation under chapter 388 of the Acts of 1910, | | | \$149,000 00 |
| Balance of appropriation under chapter 582 of the Acts of 1908, | | | 12,609 43 |
| Receipts from pumping and from other sources, | | | 3,081 59 |
| | | | \$164,691 02 |
| Amount approved by the Board for payment, | | | 160,751 00 |
| Balance, January 1, 1911, | | | \$3,940 02 ¹ |

¹ Of this balance, \$849.43 is the remaining portion of the special appropriation of \$40,000 made by chapter 582 of the Acts of 1908, for the restoration and equipment of the East Boston pumping station, on account of the Chelsea fire of April 12, 1908.

| <i>South Metropolitan System.</i> | | | | |
|--|--|--|--|--------------|
| Appropriation under chapter 340 of the Acts of 1910, | | | | \$103,200 00 |
| Receipts from pumping and from other sources, | | | | 253 50 |
| | | | | <hr/> |
| | | | | \$103,453 50 |
| Amount approved by the Board for payment, | | | | 101,781 68 |
| | | | | <hr/> |
| Balance, January 1, 1911, | | | | \$1,671 82 |

(5) ANNUAL ASSESSMENTS.

Assessments for the year, amounting to \$442,376.41, for the North Metropolitan System and to \$457,071.75 for the South Metropolitan System, were required for the payment of interest and sinking fund requirements and the cost of maintenance and operation of works. The requirements for the North Metropolitan System were: for interest, \$192,230.07; for the sinking fund, \$108,827.97; and for maintenance, \$141,318.37. For the South Metropolitan System the requirements were: for interest, \$297,553.23; for the sinking fund, \$66,097.39; and for maintenance, \$93,421.13. The assessments for the North Metropolitan System were made upon the cities and towns in the District in accordance with chapter 369 of the Acts of the year 1906. Assessments for the South Metropolitan System were likewise made in accordance with said chapter, the period of five years for which apportionment was made under decree of the Supreme Judicial Court in the year 1905 having expired with the preceding year. The respective assessments were as follows:—

| <i>North Metropolitan Sewerage System.</i> | | | | |
|--|-------------|-----------------------|--|--------------------|
| Arlington, | \$10,319 02 | Revere, | | \$13,481 40 |
| Belmont, | 5,545 04 | Somerville, | | 61,151 21 |
| Boston, | 74,329 82 | Stoneham, | | 5,084 89 |
| Cambridge, | 99,695 56 | Wakefield, | | 9,057 67 |
| Chelsea, | 26,911 34 | Winchester, | | 11,008 98 |
| Everett, | 25,610 54 | Winthrop, | | 9,662 19 |
| Lexington, | 4,066 79 | Woburn, | | 11,505 50 |
| Malden, | 39,209 87 | Total, | | <hr/> \$442,376 41 |
| Medford, | 20,901 64 | | | |
| Melrose, | 14,834 95 | | | |

South Metropolitan Sewerage System.

| | | | |
|----------------------|--------------|----------------------|--------------|
| Boston, | \$195,328 79 | Quincy, | \$28,372 01 |
| Brookline, | 83,289 83 | Waltham, | 26,502 34 |
| Dedham, | 11,219 96 | Watertown, | 13,430 95 |
| Hyde Park, | 14,148 98 | | |
| Milton, | 21,468 88 | Total, | \$457,071 75 |
| Newton, | 63,310 01 | | |

(6) EXPENDITURES FOR THE DIFFERENT WORKS.

The following is a summary of the expenditures made in the various operations for the different works:—

| CONSTRUCTION AND ACQUISITION OF WORKS. | For the Year ending December 31, 1910. | From Beginning of Work to December 31, 1910. |
|--|---|---|
| <i>North Metropolitan System.</i> | | |
| Original system, main line and branches, | - | \$5,383,957 67 |
| Lexington branch, | - | 68,585 15 |
| Everett branch, | - | 54,877 12 |
| Wakefield branch, | - | 35,698 29 |
| Stoneham branch, | - | 11,574 10 |
| Revere extension, | - | 215,722 79 |
| Chelsea and Everett outlets, | - | 71,216 41 |
| Wakefield branch extension, | - | 190,081 97 |
| Belmont extension, | - | 57,363 06 |
| Malden extension, | - | 67,092 63 |
| Bulkhead, Chelsea Creek, | - | 3,231 00 |
| North System, enlargement:— | | |
| Administration, | \$3,119 25 | \$8,917 77 |
| Deer Island pumping station, extensions and additions, | 57,308 03 | 177,707 76 |
| East Boston pumping station, extensions and additions, | 133,724 83 | 160,175 85 |
| Malden-Everett extension, Section 66, | 632 20 | 632 20 |
| Stable and locker, East Boston, | 14,281 23 | 14,362 38 |
| | \$209,065 54 | 361,795 96 |
| Total for North Metropolitan System, | \$209,065 54 | \$6,521,196 15 |
| <i>South Metropolitan System.</i> | | |
| Charles River valley sewer, main line, | - | \$800,046 27 |
| Neponset River valley sewer:— | | |
| Main line, | - | \$866,595 66 |
| Brookline branch, | - | 44,935 80 |
| | | 911,531 46 |
| High-level Sewer, | - | 5,992,375 01 |
| Amount carried forward, | | \$7,703,952 74 |

| CONSTRUCTION AND ACQUISITION OF WORKS. | For the Year ending December 31, 1910. | From Beginning of Work to December 31, 1910. |
|---|---|---|
| <i>Amount brought forward,</i> | | \$7,703,952 74 |
| <i>South Metropolitan System — Con.</i> | | |
| High-level Sewer extension:— | | |
| Completed sections, | — | \$831,627 43 |
| Administration, | \$128 29 | 15,064 14 |
| Section 85, Brighton, | 519 80 | 227,375 50 |
| Hough's Neck pumping station and connections, | 6,640 88 | 6,640 88 |
| Land takings, purchase and recording, | 192 87 | 8,118 95 |
| | \$7,481 84 | 1,088,826 90 |
| Total for South Metropolitan System, | \$7,481 84 | \$8,792,779 64 |
| Total for construction for both systems, | \$216,547 38 | \$15,313,975 79 |

| MAINTENANCE. | For the Year ending December 31, 1910. | From Beginning of Work to December 31, 1910. |
|--|---|---|
| North Metropolitan System, | \$160,751 00 | \$1,736,573 10 |
| South Metropolitan System, | 101,781 68 | 1,411,066 98 |
| Total for maintenance, both systems, | \$262,532 68 | \$3,147,640 08 |

(7) DETAILED FINANCIAL STATEMENT.

The Board herewith presents, in accordance with the Metropolitan Sewerage Acts, an abstract of the expenditures and disbursements, receipts, assets and liabilities for the year ending December 31, 1910:—

(a) Expenditures and Disbursements.

| GENERAL CHARACTER OF EXPENDITURES. | For the Year ending December 31, 1910. |
|---|---|
| CONSTRUCTION OF WORKS AND ACQUISITION BY PURCHASE OR TAKING. | |
| <i>North Metropolitan System.</i> | |
| Administration:— | |
| Commissioners, | \$1,166 67 |
| Secretary, | 375 00 |
| Clerks and stenographers, | 895 34 |
| <i>Amount carried forward,</i> | \$2,437 01 |

| GENERAL CHARACTER OF EXPENDITURES. | For the Year ending December 31, 1910. |
|--|---|
| <i>Amount brought forward,</i> | \$2,437 01 |
| <i>North Metropolitan System — Con.</i> | |
| Administration — <i>Con.</i> | |
| Traveling, | — |
| Stationery, printing and office supplies, | 404 70 |
| Telephone, lighting, heating, water and care of building, | 133 39 |
| Rent and taxes, main office, | 113 51 |
| Repairs of building, | 7 62 |
| Miscellaneous expenses, | 23 02 |
| | <u>\$3,119 25</u> |
| Engineering: — | |
| Chief engineer, | \$833 33 |
| Engineering assistants, | 4,784 52 |
| Inspectors, | 4,110 84 |
| Traveling expenses, | 320 71 |
| Stationery, printing and office supplies, | 155 69 |
| Engineering and drafting instruments and tools, | 1 60 |
| Engineering and drafting supplies, | 73 87 |
| Telephone, lighting, heating, water and care of building, | 404 77 |
| Rent and taxes, | 340 52 |
| Repairs of building, | 22 88 |
| Miscellaneous expenses, | 1,253 80 |
| | <u>12,302 53</u> |
| Advertising, | \$36 73 |
| Labor and teaming, | 26,448 17 |
| Tools, machinery and appliances, | 12,727 03 |
| Brick, cement, lumber and other field supplies and expenses, | 12,017 06 |
| | <u>51,228 99</u> |
| Contracts: — | |
| Woodbury & Leighton Co., contract 74, extension of engine, boiler, screen-house and coal-house at East Boston pumping station, | \$80,810 41 |
| Allis-Chalmers Co., contract 68, addition to pumping plant at Deer Island pumping station, | 17,307 50 |
| Robb-Mumford Boiler Co. (Robb Engineering Co., Ltd., assignee), contract 78, furnishing and erecting six vertical fire-tube boilers with smoke flue and galleries, at the East Boston pumping station, | 25,546 40 |
| Hyde Windlass Co., contract 79, furnishing two sets of screens for the Deer Island pumping station, | 5,600 00 |
| John T. Scully Foundation and Transportation Co., contract 80, pile wharf, steel floor beams, braces and coal runs, for the East Boston pumping station, | 8,618 91 |
| | <u>137,883 22</u> |
| Real estate: — | |
| Settlements, | \$4,463 40 |
| Legal, conveyancing and expert, | 68 15 |
| | <u>4,531 55</u> |
| Total for North Metropolitan System, | \$209,065 54 |

GENERAL CHARACTER OF EXPENDITURES.

For the Year ending
December 31, 1910.*South Metropolitan System.**High-level Sewer Extension.*

Administration:—

| | |
|---|----------|
| Commissioners, | — |
| Secretary, | — |
| Clerks and stenographers, | — |
| Traveling, | — |
| Stationery, printing and office supplies, | \$90 71 |
| Telephone, lighting, heating, water and care of building, | 26 26 |
| Rent and taxes, main office, | 11 32 |
| Miscellaneous expenses, | — |
| | \$128 29 |

Engineering:—

| | |
|---|------------|
| Chief engineer, | — |
| Engineering assistants, | \$1,132 83 |
| Inspectors, | 402 78 |
| Traveling expenses, | — |
| Stationery, printing and office supplies, | 79 35 |
| Engineering and drafting instruments and tools, | — |
| Engineering and drafting supplies, | 8 18 |
| Telephone, lighting, heating, water and care of building, | 78 70 |
| Rent and taxes, | 33 95 |
| Miscellaneous expenses, | — |
| | 1,735 79 |

Advertising,

| | |
|--|----------|
| Labor and teaming, | \$34 89 |
| Tools, machinery and appliances, | 31 00 |
| Brick, cement, lumber and other field supplies and expenses, | 474 43 |
| | 1,438 89 |

Contracts:—

| | |
|---|----------|
| Hugh Nawn Contracting Co., contract 65, Section 85, in part, | \$500 00 |
| John Cashman & Sons Co., contract 87, Hough's Neck pumping station, | 2,945 68 |

Real estate:—

| | |
|---------------------------------|----------|
| Settlements, | \$192 87 |
| Legal, conveyancing and expert, | — |
| | 192 87 |

Total for South Metropolitan System,

\$7,481 84

MAINTENANCE AND OPERATION OF WORKS.

North Metropolitan System.

Administration:—

| | |
|---------------------------|------------|
| Commissioners, | \$2,333 33 |
| Secretary and assistants, | 2,971 25 |
| Rent, | 325 43 |
| Amount carried forward, | \$5,630 01 |

| GENERAL CHARACTER OF EXPENDITURES. | For the Year ending December 31, 1910. |
|---|---|
| <i>Amount brought forward,</i> | \$5,630 01 |
| <i>North Metropolitan System — Con.</i> | |
| Administration — <i>Con.</i> | |
| Heating, lighting and care of building, | 216 62 |
| Repairs of building, | 128 38 |
| Postage, | 86 00 |
| Printing, stationery and office supplies, | 692 89 |
| Telephones, | 59 28 |
| Traveling expenses, | 35 91 |
| Miscellaneous expenses, | 41 63 |
| | <hr/> |
| | \$6,890 72 |
| General supervision:— | |
| Chief engineer and assistants, | \$6,387 59 |
| Rent, | 976 32 |
| Heating, lighting and care of building, | 614 15 |
| Repairs of building, | 385 17 |
| Postage, | — |
| Printing, stationery and office supplies, | 249 07 |
| Telephones, | 177 85 |
| Traveling expenses, | 155 00 |
| Miscellaneous expenses, | 76 83 |
| | <hr/> |
| | 9,021 98 |
| Deer Island pumping station:— | |
| Labor, | \$15,669 91 |
| Fuel, | 12,341 20 |
| Oil and waste, | 439 66 |
| Water, | 1,268 40 |
| Packing, | 264 16 |
| Repairs and renewals, | 1,244 57 |
| Telephones, | 195 05 |
| General supplies, | 1,561 00 |
| Miscellaneous supplies and expenses, | 231 72 |
| | <hr/> |
| | 33,215 67 |
| East Boston pumping station:— | |
| Labor, | \$18,317 42 |
| Fuel, | 10,362 06 |
| Oil and waste, | 424 80 |
| Water, | 1,644 00 |
| Packing, | 50 24 |
| Repairs and renewals, | 623 08 |
| Telephones, | 140 95 |
| General supplies, | 636 68 |
| Miscellaneous supplies and expenses, | 113 93 |
| | <hr/> |
| | 32,313 16 |
| Charlestown pumping station:— | |
| Labor, | \$14,209 60 |
| Fuel, | 3,838 56 |
| Oil and waste, | 266 74 |
| | <hr/> |
| <i>Amounts carried forward,</i> | \$18,314 90 \$81,441 53 |

| GENERAL CHARACTER OF EXPENDITURES. | For the Year ending December 31, 1910. |
|---|---|
| <i>Amounts brought forward,</i> | \$18,314 90 \$81,441 53 |
| <i>North Metropolitan System — Con.</i> | |
| Charlestown pumping station — <i>Con.</i> | |
| Water, | 453 60 |
| Packing, | 33 27 |
| Repairs and renewals, | 364 99 |
| Telephones, | 67 85 |
| General supplies, | 323 02 |
| Miscellaneous supplies and expenses, | 97 56 |
| | 19,655 19 |
| Alewife Brook pumping station:— | |
| Labor, | \$7,553 00 |
| Fuel, | 1,795 84 |
| Oil and waste, | 231 20 |
| Water, | 276 84 |
| Packing, | 60 63 |
| Repairs and renewals, | 461 03 |
| Telephones, | 50 22 |
| General supplies, | 85 15 |
| Miscellaneous supplies and expenses, | 43 25 |
| | 10,562 16 |
| Sewer lines, buildings and grounds:— | |
| Engineering assistants, | \$2,575 00 |
| Labor, | 24,996 32 |
| Automobiles, | 88 82 |
| Brick, cement and lime, | 628 14 |
| Castings, ironwork and metals, | 273 25 |
| Freight, express and teaming, | 10 66 |
| Fuel and lighting, | 270 18 |
| Jobbing and repairing, | 119 69 |
| Lumber, | 592 82 |
| Machinery, tools and appliances, | 545 13 |
| Paints and oils, | 539 64 |
| Rubber and oiled goods, | 685 82 |
| Sand, gravel and stone, | 286 06 |
| Telephones, | 10 10 |
| Traveling expenses, | 504 19 |
| General supplies, | 575 24 |
| Miscellaneous expenses, | 274 73 |
| | 32,975 79 |
| Horses, vehicles and stable account, | \$4,356 33 |
| Renewal East Boston pumping station, account Chelsea fire, April 12, 1908:— | |
| Supplies and expenses, | 11,760 00 |
| | 16,116 33 |
| Total for North Metropolitan System, | \$160,751 00 |
| <i>South Metropolitan System.</i> | |
| Administration:— | |
| Commissioners, | \$2,333 33 |
| Secretary and assistants, | 1,745 12 |
| <i>Amount carried forward,</i> | \$4,078 45 |

| GENERAL CHARACTER OF EXPENDITURES. | For the Year ending December 31, 1910. |
|---|---|
| <i>Amount brought forward,</i> | \$4,078 45 |
| <i>South Metropolitan System — Con.</i> | |
| Administration — <i>Con.</i> | |
| Rent, | 155 00 |
| Heating, lighting, and care of building, | 201 85 |
| Repairs of building, | 64 20 |
| Postage, | 76 00 |
| Printing, stationery and office supplies, | 623 56 |
| Telephones, | 56 48 |
| Traveling expenses, | 10 51 |
| Miscellaneous expenses, | 27 78 |
| | \$5,293 83 |
| General supervision:— | |
| Chief engineer and assistants, | \$7,561 59 |
| Rent, | 465 00 |
| Heating, lighting and care of building, | 605 57 |
| Repairs of building, | 192 58 |
| Postage, | — |
| Printing, stationery and office supplies, | 180 09 |
| Telephones, | 169 35 |
| Traveling expenses, | 60 00 |
| Miscellaneous expenses, | 102 28 |
| | 9,336 46 |
| Ward Street pumping station:— | |
| Labor, | \$18,446 02 |
| Fuel, | 6,850 69 |
| Oil and waste, | 329 24 |
| Water, | 1,410 00 |
| Packing, | 111 65 |
| Repairs and renewals, | 336 82 |
| Telephones, | 95 49 |
| General supplies, | 971 88 |
| Miscellaneous supplies and expenses, | 162 77 |
| | 28,715 46 |
| Quincy pumping station:— | |
| Labor, | \$6,273 60 |
| Fuel, | 1,654 52 |
| Oil and waste, | 44 01 |
| Water, | 114 85 |
| Packing, | 24 66 |
| Repairs and renewals, | 273 25 |
| Telephones, | 37 82 |
| General supplies, | 82 79 |
| Miscellaneous supplies and expenses, | 247 57 |
| | 8,753 07 |
| Nut Island screen-house:— | |
| Labor, | \$7,129 17 |
| Fuel, | 1,568 45 |
| Oil and waste, | 56 51 |
| <i>Amounts carried forward,</i> | \$8,754 13 \$52,098 82 |

| GENERAL CHARACTER OF EXPENDITURES. | For the Year ending December 31, 1910. |
|---|---|
| <i>Amounts brought forward,</i> | \$8,754 13 \$52,098 82 |
| <i>South Metropolitan System — Con.</i> | |
| Nut Island screen-house — <i>Con.</i> | |
| Water, | 179 28 |
| Packing, | 28 69 |
| Repairs and renewals, | 29 11 |
| Telephones, | 60 80 |
| General supplies, | 429 96 |
| Miscellaneous supplies and expenses, | 40 29 |
| | — 9,522 26 |
| Sewer lines, buildings and grounds: — | |
| Engineering assistants, | \$3,400 00 |
| Labor, | 18,653 48 |
| Automobiles, | 2,411 87 |
| Brick, cement and lime, | 136 03 |
| Castings, ironwork and metals, | 109 16 |
| Freight, express and teaming, | 25 |
| Fuel and lighting, | 71 72 |
| Jobbing and repairing, | 19 64 |
| Lumber, | 119 38 |
| Machinery, tools and appliances, | 2,858 48 |
| Paints and oils, | 427 52 |
| Rubber and oiled goods, | 163 21 |
| Sand, gravel and stone, | 18 75 |
| Telephones, | 34 85 |
| Traveling expenses, | 605 24 |
| General supplies, | 149 83 |
| Miscellaneous expenses, | 30 63 |
| | — 29,210 04 |
| City of Boston, for pumping and interest, | 7,700 00 |
| Horses, vehicles and stable account, | 3,250 56 |
| Total for South Metropolitan System, | \$101,781 68 |

(b) Receipts.

The receipts from the sales of property, from rents and from other sources, have been credited as follows: —

| ACCOUNT. | For the Year ending December 31, 1910. | From Beginning of Work to December 31, 1910. |
|---|---|---|
| North Metropolitan System — construction, . | \$254 59 | \$63,391 78 |
| South Metropolitan System — construction, . | 1,994 31 | 13,401 13 |
| North Metropolitan System — maintenance, . | 3,081 59 | 14,641 23 |
| South Metropolitan System — maintenance, . | 253 50 | 1,730 20 |
| Metropolitan Sewerage Loans Sinking Fund, . | 182 19 | 1,543 39 |
| Totals, | \$5,766 18 | \$94,707 73 |

(c) Assets.

The following is an abstract of the assets of the Sewerage Works, a complete schedule of which is kept on file in the office of the Board:—

Office furniture, fixtures and supplies; engineering and scientific instruments and supplies; horses, vehicles, field machinery, etc.; machinery, tools and other appliances and supplies; real estate connected with works not completed; completed works, including real estate connected therewith.

(d) Liabilities.

The sums due on monthly pay rolls amount to \$757.22, and there are other current bills unpaid which have not yet been received.

Amounts on Monthly Estimates, not due until Completion of Contracts or until Claims are settled.

| NAME. | Work. | Amount. |
|---|--|-------------------------------------|
| High-level Sewer:— National Contracting Co., . . . E. W. Everson & Co., . . . | Sect. 73, contract abandoned, Sect. 75, contract 14, | \$5,516 17 ¹ 1,000 00 |
| High-level Sewer Extension:— Timothy J. O'Connell, . . . Geo. M. Bryne Co., . . . John Cashman & Sons Co., . . . | Sect. 82, in part, contract 57, Sect. 85, in part, contract 63, Hough's Neck pumping station and connections, contract 87, | 60 00 2,508 51 519 82 |
| North Metropolitan Construction:— Allis-Chalmers Co., . . . | Addition to pumping plant at Deer Island pumping station, contract 68, | 17,307 50 |
| Robb-Mumford Boiler Co. (Robb Engineering Co., Ltd., assignee), . . . Woodbury & Leighton Co., . . . | Furnishing and erecting six vertical fire-tube boilers with smoke flue and galleries, at the East Boston pumping station, contract 78, Extension of engine, boiler, screen-house and coal house at East Boston pumping station:— Contract 74A (maintenance), Contract 74B (construction), | 6,386 60 865 00 8,681 73 |
| | | \$42,845 33 |

¹ Damages claimed by the Commonwealth on account of the abandonment of the contract exceed this amount.

Claims have been made by the following parties, but it is impossible to state the amounts due for land and other damages, as no sums have been agreed upon, and suits are now pending in the courts for the determination of most of them:—

Anna L. Duncan, Carrie S. Urquhart, N. Jefferson Urquhart, Edwin N. Urquhart, Richard Jones, James Doherty, Michael Niland, William H. Gibbons, Francis Normile, George A. Goddard.

VIII. RAINFALL AND WATER SUPPLY.

The amount of rain has been almost unprecedentedly small during the past year, and the scarcity has been more felt because for a period of years preceding there has been a rainfall less than the normal. The average rainfall for the past thirty-six years in which the records have been kept on the Sudbury watershed, is 45.31 inches, but during the past year the rainfall was but 35.64 inches. The rainfall on the Wachusett watershed was but 37.85 inches, against an average rainfall of 47.08 inches since the beginning of the records in the year 1897.

The amount of water collected and contributed to the water supply, which is affected by various circumstances, does not, however, exactly correspond to the rainfall. The yield or amount of water collected on the Sudbury watershed in the year 1910 was only 56 per cent. of the average amount of the years since the measurements have been made; and the amount so collected on the Wachusett watershed was but 73 per cent. of the average.

The accompanying diagram illustrates the remarkably small amount of water collected for the water supply during the past year in comparison with the previous years, and it also shows the comparatively smaller amounts collected during the past few years.

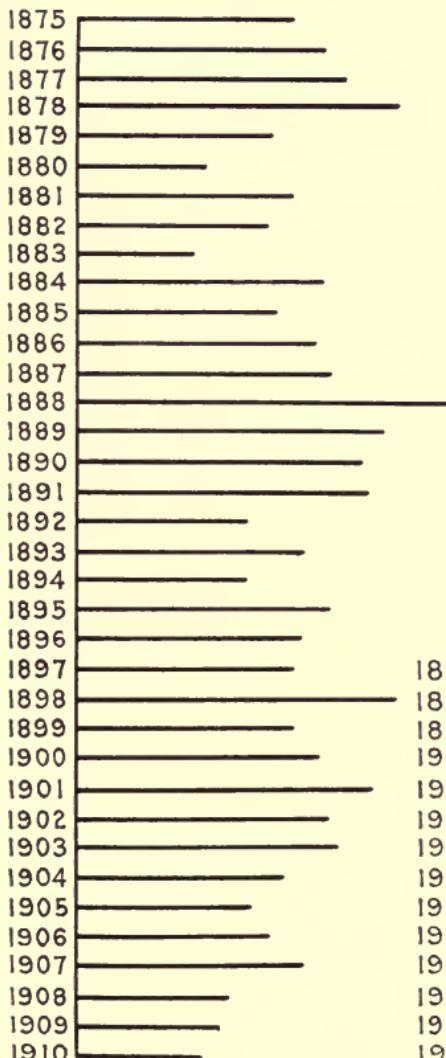
IX. CONSUMPTION OF WATER.

There has been for the second year a gratifying reduction in the total consumption of water in the Metropolitan District. The daily average consumption of water in the District in the year 1910 has been 112,092,100 gallons, which is a decrease of 7,027,000 gallons from the consumption of the year 1909, while that year showed a decrease in the daily average consumption of 6,305,100 gallons. The daily average consumption of each person in the District was 110 gallons, as against 119 gallons per person in the year 1909, and 129 gallons per person in the year 1908. These are the quantities determined by the Venturi meters as delivered to the various cities and towns. The quantity delivered to the District, according to the computation of water pumped at the several pumping stations and flowing in the Weston Aqueduct, including the small yield of the Spot Pond watershed, would, principally

COMPARATIVE AMOUNTS OF WATER COLLECTED IN THE
DIFFERENT YEARS ON THE SUDBURY AND WACHUSSETT
WATERSHEDS PER SQUARE MILE OF WATERSHED.

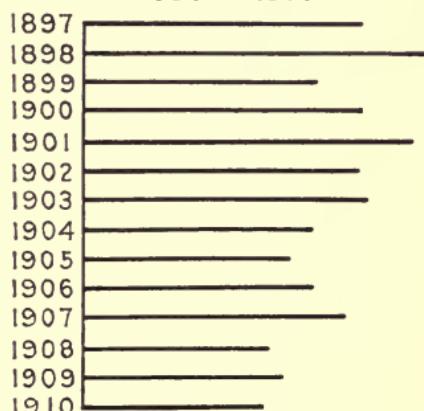
SUDBURY WATERSHED.

1875 — 1910



WACHUSSETT WATERSHED.

1897 — 1910





owing to leakage from distributing reservoirs and the Metropolitan pipes, and the small amounts supplied outside of the District, slightly exceed these figures.

There has been a decrease in daily consumption per capita in all the municipalities except Arlington, Belmont, Lexington, Malden, Melrose, Revere, Stoneham, Swampscott and Watertown. In the town of Winthrop there has been a decrease of 28 gallons daily per capita, and in the city of Medford a decrease of 16 gallons daily per capita, while in the city of Boston the daily per capita decrease has been 13 gallons. The total reduction of the consumption of the latter city for the year was 6,683,200 gallons, which makes up nearly the entire reduction in consumption of the District.

Of the municipalities named, in which there has been a per capita increase in the consumption, Stoneham shows a daily increase of 9 gallons and Watertown of 8 gallons. In the other municipalities the per capita increases have been small.

The notable reductions in the consumption in the cities of Boston and Medford and in the town of Winthrop have followed the larger installation of meters in those municipalities.

Although the reduction in consumption during the past year was assisted by the generally favorable character of the weather, and by the adoption on the part of the municipalities of more rigorous inspection and other preventive measures, it is undoubtedly principally due to the larger introduction of meters.

During the past year there has been a substantial compliance with the provisions of the Meter Act of 1907 by all the municipalities except the town of Revere and the city of Quincy. The city of Boston, on account of its almost total failure to observe the requirements of the law in the year 1908, is still behindhand in the total required to be installed on services in use on January 1, 1908 by about 2,200 meters, and its per cent., 19.96 per cent. of services metered, is the lowest of any municipality.

The town of Revere, although it introduced meters upon its new services, installed them upon less than 5 per cent. of old services as required by the Meter Act.

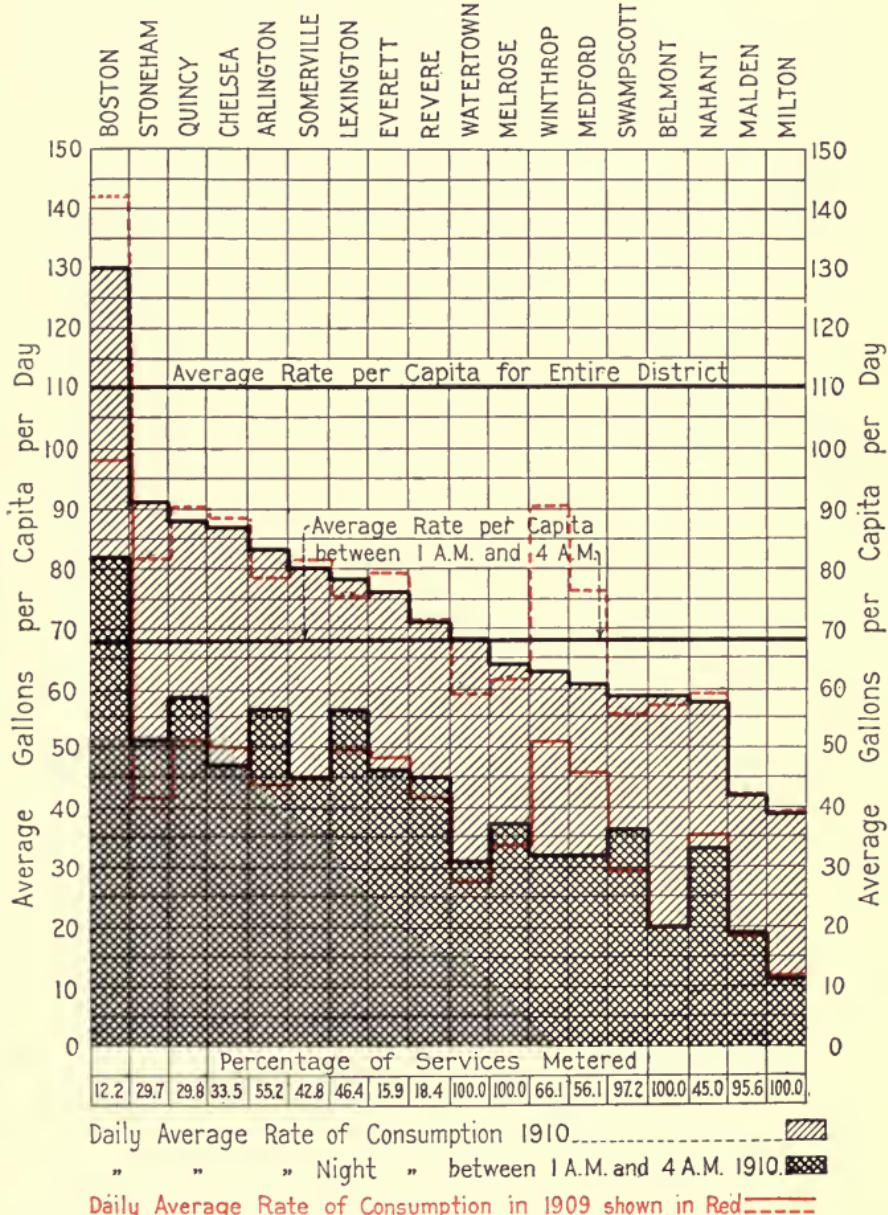
The city of Quincy failed in the year 1909 to comply with the provisions of the Meter Act, both as to the metering of the required percentage of old services and in the equipment of all new services.

The Board, in compliance with the provisions of chapter 177 of the Acts of 1909, gave notice of the neglect of the city to the Attorney-General, who brought action before the Supreme Judicial Court to enforce the requirements of the Act, and also for the forfeiture to the Commonwealth of the penalties prescribed. By reason, however, of the representations made by the officials of the city as to the measures which they were taking in order to install the necessary number of meters, further proceedings in the suit were suspended. A large number of meters were installed during the latter portion of the year, and it is understood that during the coming year the city will have fully complied with the terms of the Act, and will not compel the further prosecution of the action which is pending.

The city of Melrose and the towns of Belmont, Milton and Watertown have metered all their services. The town of Swampscott, the city of Malden, the town of Winthrop and the city of Medford have installed meters to the extent respectively of 99, 96, 96 and 94 per cent. of the services. At the end of the year, 37.56 per cent. of all the services in the Metropolitan District were metered, a gain during the year of 9.21 in the percentage.

The fact still remains, notwithstanding the reductions which have been made, that there is an excessive use and great waste of water in the Metropolitan District. The diagram which is again reproduced, showing the average rate of consumption in the year 1910 during the entire day and between the hours of 1 and 4 in the night, significantly demonstrates this fact. The daily average rate of consumption per capita in the night, when necessary use is comparatively very small, is 68 gallons. This night rate in the city of Boston is 60 per cent. of the rate for the entire day, and exceeds the rate for the entire day of 13 municipalities. The result which has been brought about by the metering of even 19.96 per cent. of the services in the city of Boston, and the somewhat greater efforts which have been made by the authorities to restrict unnecessary use, conclusively indicate the importance of universal metering and more vigorous measures for the prevention of excessive use and waste, especially in that city which consumes 78 per cent. of all the water supplied. The city of Boston alone can put off for a long period in the future the necessity of a great expenditure for the acquisition of additional sources of supply and of new and expensive works.

DIAGRAM SHOWING
AVERAGE RATE OF CONSUMPTION OF WATER
IN THE METROPOLITAN DISTRICT IN 1910
DURING THE ENTIRE DAY
AND
BETWEEN THE HOURS OF 1 AND 4 AT NIGHT



X. RECOMMENDATIONS FOR LEGISLATION.

The Board in its preliminary report to the Legislature has made no requests for the authorization of additional expenditures for the construction of new works, either for the Water or Sewerage systems, and the loans already authorized are deemed sufficient for the completion of the works in progress.

The Board has requested the passage of an act providing that in case the town of Braintree should apply for admission into the South Metropolitan Sewerage District, and an extension of the sewer into that town should thus become necessary, balances in the treasury not needed for the purposes for which the appropriations were made may be used for the Braintree extension, and thus avoid the necessity of the immediate issue of further bonds.

XI. FUTURE WORK.

The maintenance and operation of the various works for the supply and distribution of water in the cities and towns of the Metropolitan Water District, and of the works constructed for the collection and disposal of the sewage in the cities and towns of the North and South Metropolitan Sewerage districts, will require, according to the estimates for the current year which have been made and submitted to the Legislature, appropriations amounting to \$674,400. In these estimates, in addition to the ordinary current expenditures, the Board has included the sum of \$15,000, which it deems necessary to expend for the protection of the water supply in aqueducts. The growth of the population having caused the construction of new houses in districts adjacent to the aqueducts before local sewers have been provided, it has become necessary to provide, temporarily at least, for the house drainage in such adjacent districts so as to prevent the pollution of the water carried through the aqueducts.

The carrying out of projects already begun will require a considerable amount of construction during the coming year. The installation of a power plant at the Wachusett Dam, by which electricity will be generated and for which contracts have already been made, will be carried on to completion. The tunnel and pipe line for the improvement of the East Boston water supply will be finished and put into operation, a further section of the 60-inch

supply pipe line, which is to extend from the Weston Aqueduct to the Chestnut Hill Reservoir, will be made ready and put into service, and the new engine, which is in process of erection at the Chestnut Hill pumping station, will be completed and put into operation.

In the North Sewerage System the final work in the extensions of the Deer Island and East Boston pumping stations and installation of new pumping machinery will be accomplished, and the new stable and locker building will be constructed; and in the South Sewerage System the small station in process of construction for lifting the sewage of a portion of the city of Quincy into the High-level Sewer will be completed and put into operation. If the town of Braintree applies for admission into the South Metropolitan Sewerage District it will be necessary to proceed at once to the construction of a sewer from a point in Quincy to connect with the sewerage system in the town of Braintree, for which the expenditure of \$100,000 has been authorized.

Requests for information have been made by various municipalities relative to their admission into the Metropolitan Water District. Some of these municipalities are situated within the ten-mile limit, and it is made by the Metropolitan Water Act obligatory upon the Board to grant their applications for admission on their payment of such sums as the Board shall determine. Municipalities outside of the limit can only be admitted by act of the Legislature. In case other cities or towns are admitted new work of greater or less magnitude will be called for.

The town of Hyde Park, which belongs to the Metropolitan Water District, but has not yet asked to be furnished with water, has been considering for some time the question of resorting to the Metropolitan Works for its supply. In case the town shall so vote it will become at once the duty of the Board to proceed to make connection with the local water system of the town, and construct such new works as may be required in order to furnish a proper water supply.

The large amount of sewage which is now carried into the harbor through the Deer Island outlet has caused the Board to consider the desirability of making some improvement in the future in the method of its discharge. Various inquiries have been instituted in

the matter, but further investigations will be required as to the effect of the disposal of the sewage in the harbor and to determine what measures may be adopted in order to secure the best and most effective method by which the sewage can be discharged into the sea from the North Metropolitan System.

The detailed reports of the Chief Engineer of the Water Works and of the Chief Engineer of the Sewerage Works, with various tables and statistics are herewith presented.

Respectfully submitted,

HENRY H. SPRAGUE,
HENRY P. WALCOTT,
JAMES A. BAILEY, JR.,
Metropolitan Water and Sewerage Board.

BOSTON, February 27, 1911.

REPORT OF CHIEF ENGINEER OF WATER WORKS.

To the Metropolitan Water and Sewerage Board.

GENTLEMEN:—The following is a report of the work under the charge of the Chief Engineer of the Metropolitan Water Works for the year ending December 31, 1910.

GENERAL STATEMENT.

The Chief Engineer has charge of the design and construction of all new works, and of the maintenance and operation of all the works controlled by the Metropolitan Water and Sewerage Board for supplying water to the eighteen municipalities which have received their supply from the Metropolitan Works.

ORGANIZATION.

The Chief Engineer has had the following assistants:—

| | |
|---------------------------|--|
| William E. Foss, . . . | <i>Assistant to Chief Engineer.</i> |
| Elliot R. B. Allardice, . | <i>Superintendent, Wachusett Department.</i> |
| Charles E. Haberstroh, | <i>Superintendent, Sudbury Department.</i> |
| Samuel E. Killam, . . . | <i>Superintendent, Pipe Lines and Reservoirs, Distribution Department.</i> |
| Arthur E. O'Neil, . . . | <i>Superintendent, Pumping Stations, Distribution Department.</i> |
| Alfred O. Doane, . . . | <i>Division Engineer, specially in charge of engineering work at pumping stations.</i> |
| George E. Howe, . . . | <i>Assistant Engineer, resigned April 30, 1910.</i> |
| Barzillai A. Rich, . . . | <i>Assistant Engineer, employed since June 8, 1910.</i> |
| Clifford Foss, . . . | <i>Assistant Engineer.</i> |
| Benjamin F. Hancox, . | <i>Assistant, in charge of Drafting Department.</i> |
| James W. Killam, . . . | <i>Assistant Engineer, in charge of tests of coal and oil.</i> |
| William E. Whittaker, . | <i>Office Assistant.</i> |
| Arthur W. Walker, . . . | <i>Biologist.</i> |
| William W. Locke, . . . | <i>Sanitary Inspector.</i> |

At the beginning of the year the engineering force, including those engaged upon both the construction and maintenance of the works, numbered 48, and at the end of the year 51.

There has also been a maintenance force, exclusive of the engineers above mentioned, averaging 249, employed in the operation of the several pumping stations and in connection with the maintenance of the reservoirs, aqueducts and pipe lines, and in doing minor construction work.

The number of men employed in the maintenance force of the several departments has been as follows:—

| | Beginning of Year. | End of Year. | Average. |
|---|-----------------------|-----------------|----------|
| Wachusett Department, | 37 | 39 | 49 |
| Sudbury Department. | 43 | 56 | 53 |
| Distribution Department, pipe lines and reservoirs, . . . | 76 | 91 | 88 |
| Distribution Department, pumping service, . . . | 60 | 58 | 59 |
| | 216 | 244 | 249 |

In addition to the men employed directly by the Board a force averaging 167 men, reaching a maximum of slightly over 300 in September, was employed from April 1 to December 31 by the contractors engaged in constructing new works.

CONSTRUCTION.

NEW 60-INCH SUPPLY MAIN FROM WESTON AQUEDUCT.

An expenditure of \$750,000 was authorized by the Legislature of 1909 for the construction of a second Weston Aqueduct supply main, for the purpose of increasing the amount of water that can be supplied from the Weston Aqueduct into the Metropolitan District.

The new main will extend from the Charles River at Commonwealth Avenue in Newton to Beacon Street at Chestnut Hill Avenue in Boston, a distance of about 34,650 feet, and will be located for a large portion of the distance in Commonwealth Avenue. On account of the large reduction now being made in the amount of water used in the District it has not been deemed necessary to construct the entire line at present, and the work of construction

is therefore being confined to the portion of the line extending 20,255 feet westerly from the lower end, at Beacon Street in Boston. This section of the pipe line has been connected at the lower end with the low-service mains in Beacon Street, and at the upper end it will be connected with the existing 48-inch Weston Aqueduct supply main, near Valentine Street, in Newton, and when put into service it will materially increase the amount of water that can be drawn from the Weston Aqueduct.

Cast-iron pipes 60 inches in diameter have been used in constructing the line, except for a distance of 2,395 feet, where the water will be carried through a concrete-lined rock tunnel 76 inches in diameter, connected with the 60-inch pipes by steel pipes 80 inches in diameter. The steel pipes will be protected from corrosion on the inside by a Portland cement mortar lining 2 inches thick, and on the outside by a backing of Portland cement concrete, which will also serve as a support for the pipe.

The tunnel and steel pipe line are being constructed of larger capacity than the remainder of the line in order to provide carrying capacity for an additional pipe line in the future.

Contracts for furnishing the cast-iron pipe and most of the special castings for the portion of the line now under construction were made in 1909. Contracts for the special castings required to complete the work have been made during the past year. A contract for furnishing the steel pipe was made with the Hodge Boiler Works on December 6, but the delivery of the pipe will not be made until 1911. The portion of the pipe line under construction has been subdivided into three sections, known as sections 6, 7 and 8.

Section 6 is located in Commonwealth Avenue in Newton, and extends from a point midway between Prince and Valentine streets to Grant Avenue, at Section 7, a distance of 8,825 feet. The contract for doing this work was made with Cavanagh Brothers of Boston, on June 2. On the following day a special steam shovel excavator, designed by the contractor, was set up near Grant Avenue, where trench excavation was started on June 8. Pipe laying was begun at this point on June 15 and on July 16 about 650 feet of pipe had been laid. The force employed at this time was about 35 men.

On account of difficulties arising in connection with the use of the steam shovel and dump cars, and from obstacles encountered in the trench, slow progress was made in pipe laying. The contractor therefore increased his force to about 75 men, abandoned the use of the cars, and employed teams for transporting the excavated material. This change in method of carrying on the work resulted in the making of better progress and this organization was continued until the completion of the work.

Trench excavation was started at the large culvert near Walnut Street on July 18, and 700 feet of trench at this place was excavated by manual labor. Pipe laying was completed and the line capped at the westerly end, between Prince and Valentine streets, on November 26.

A 36-inch branch was set in the line near Valentine Street for a connection with the 48-inch Weston Aqueduct supply main. A 36-inch valve with 6-inch by-pass was set in the line just west of this branch. A blow-off branch into the Cochituate Aqueduct was placed at Irving Street.

The surplus material from the easterly 6,000 feet of the line was sand and gravel, and was teamed to Section 7, where a portion of it was used in building the embankment over the 60-inch pipe line, and the remainder placed in a storage pile to be used for filling the steel pipe trench on that section. The entire work was completed on December 3. The value of the work done under this contract was \$40,777.77.

Section 7 of the new pipe line is located in Newton, and extends from Commonwealth Avenue at Grant Avenue through and under private land to the westerly end of Section 8. It includes 2,042 feet of concrete-lined rock tunnel, 353 feet of cement-lined steel pipe and 940 feet of 60-inch cast-iron pipe.

A contract for this work was made with Joseph Hanreddy of Chicago on April 28. The work of excavating the trench at the west end of the section was begun on May 24, with a force of about 20 men and 9 horses, preparatory to laying the pipe at this place. This force was later increased to about 55 men.

Steam plants, with air compressors for operating the drills, dynamos for lighting the tunnel and engines for operating the stone crushers have been installed at both ends of the tunnel.

ARTHUR D. BUBBY, C.E.

The laying of 60-inch pipe was begun at Commonwealth Avenue on June 7, and continued in an easterly direction until June 14, when 334 feet of pipe had been laid. This section of the line was laid near the surface of the ground, and covered with an embankment built of surplus material from the 60-inch pipe trench on Section 6.

On June 17 the laying of pipe was begun at the easterly end of the section, and continued westerly until July 1, when 185 feet of pipe had been laid. A 36-inch valve with 6-inch by-pass was set in the line at this point, and a 16-inch blow-off pipe was laid into the culvert under the Cochituate Aqueduct near the ventilator chamber. Pipe laying was resumed at this place on September 15 and continued to October 1. The total length of 60-inch pipe laid to date on this section is 664 feet.

On July 7 the steam plant at the west end of the tunnel was put into operation, and on July 13 the crushing of rock from the open trench was commenced. Rock excavation in the open trench was completed July 23, and tunnel excavation was begun on July 26 at the west portal. Night work was begun at the west heading on August 1, and tunnel excavation was then continued with two shifts at this heading.

The tunnel is excavated 9 feet in diameter, and is located about 9 feet north of and 20 feet above the old Cochituate Aqueduct tunnel, which was constructed through the hill at this place by the city of Boston in 1848.

Tunnel excavation was begun at the east portal on September 9, and night work was commenced on September 19. The excavation of the tunnel was then continued, with night and day forces, from the east portal until December 24, and from the west portal until December 29. The force employed at each heading consisted of about 12 men on each shift. From 15 to 21 holes, from 5 to 6 feet in depth, were drilled per shift in each heading, and then blasted, and the progress made when working two shifts at both headings was about 20 linear feet per working day.

The material excavated at the west heading was soft conglomerate rock, with a few hard spots in places, and comprised about three-fourths of the tunnel excavation. This rock was free from seams

and broke close to the established line for tunnel excavation. At the east end of the tunnel the rock was hard and brittle, with numerous fissures and cracks, which caused the excavation to break out unnecessarily large at some places, and timbering was required for about 30 feet. Timbering was also required to support the rock at six old shafts on the Cochituate Aqueduct tunnel, and at an earth seam near the westerly end of the tunnel.

On December 28 a hole was broken through from the west heading into the east heading of the tunnel. After the muck was removed the entire force was discharged, and the work suspended for the winter on December 31. With the exception of a little trimming the tunnel excavation is now completed.

The value of the work done to date under this contract is \$65,385.41, equivalent to about 60 per cent. of the total value of the work to be done.

At the west end the length of tunnel excavation was 1,210 feet, and at the east end 832 feet, making a total length of 2,042 feet. The average length of tunnel excavated per working day was 15.1 feet. At the west end of the tunnel 5,553 cubic yards of stone have been crushed, of which 1,924 cubic yards have been used for resurfacing the 60-inch pipe trench in Commonwealth Avenue. At the east end of the tunnel 4,226 cubic yards of stone have been crushed.

About 2.30 A.M. on December 6, powderman Constanzo Tramanzozzi was killed by the explosion of the dynamite which was to be used for loading the holes in the east heading of the tunnel. The cause of the explosion is not known.

Section 8 includes the easterly 8,095 feet of the proposed line, 3,100 feet of which is located in private land in Newton and 4,995 feet in Commonwealth and Chestnut Hill avenues in Boston.

Work on this section, which was begun last year by the Charles J. Jacobs Company, was suspended for the winter on December 24, 1909, after 5,349 feet of pipe had been laid. The work was resumed on March 30, 1910, and was continued with a force of from 40 to 80 men. The work progressed slowly, on account of the large amount of rock which had to be excavated in the trenches on Commonwealth Avenue, and was not completed until August 10.

A 60-inch Venturi meter, with 27-inch throat, was set in the pipe line on Chestnut Hill Avenue near Beacon Street, where the main connects with the existing 48-inch main.

The value of the work done by the C. J. Jacobs Company during the year was \$14,622.86, making the total cost of the work done by this contractor \$40,525.39.

The length of 60-inch pipe laid during the year was 2,746 feet, making a total length laid of 8,095 feet, and the amount of rock excavated during the year was 1,092 cubic yards, making a total of 3,610 cubic yards.

The value of all work done on the construction of the new supply main to date is as follows:—

| | |
|--|------------------|
| Pipes, special castings and valves, | \$209,710 61 |
| Venturi meter, | 2,350 00 |
| Laying pipes, including pipe-laying materials and earth excavation, | 61,061 58 |
| Rock excavation in trenches, | 15,735 50 |
| Tunnel excavation, Section 7, | 50,245 50 |
| Earth excavation for trenches, Section 7, | 3,712 20 |
| Crushing stone, Section 7, | 7,334 25 |
| Valve chambers and concrete backing for curves, | 2,407 00 |
| Work in connection with changes in underground structures, | 6,765 56 |
| Resurfacing trench in Commonwealth Avenue, Section 6, labor by city of Newton, | 4,357 16 |
| Additional expenses, | 9,854 64 |
| Engineering, | 15,173 08 |
| Total, | \$388,707 08 |

16-INCH FORCE MAIN IN ARLINGTON.

The 16-inch main leading from the Arlington pumping station has been extended from Massachusetts Avenue through Robbins Road, Hawthorne and Park avenues to the standpipe on Arlington Heights, a distance of 3,750 feet. The work of laying the main was done by Devincenzi & Baruffoldi under a contract dated May 5, 1910. The contractor began work on May 11, employed an average force of 22 men and completed the pipe laying on July 28. The value of the work done under this contract, which included the laying of 3,742 feet of 16-inch pipe and excavation of 408 cubic yards of rock, was \$3,333.31. Connections between this main and existing pipes

were made by the maintenance force, which also made 8 wooden insulating joints on the pipe line. The total cost of the work, exclusive of engineering, was \$10,094.02.

The laying of this main reduced by about 5 feet the head or pressure on the pumps at the Arlington station, and at the same time relieved the pressure on the Arlington pipe system.

NEW 16-INCH MAIN FOR SUPPLY OF SWAMPSMOTT.

A 16-inch main 4,700 feet long has been laid from the corner of Ocean and Nahant streets in Lynn, through Ocean and New Ocean streets to the Swampscott line, for the purpose of improving the supply to the town of Swampscott. A contract for laying this main was made with C. M. Callahan on April 22, 1910. Work was begun at the Swampscott line on April 29. Pipe laying was completed on June 16 and the resurfacing of the trench on June 30. The new main was connected with the old 12-inch main at each end, and 11 wooden insulating joints were made on the line by the maintenance force.

The value of work done by contract was \$4,518.30. The whole cost of the work, including work done by the maintenance force and materials used, was \$14,009.70.

• NEW SUPPLY MAIN TO EAST BOSTON.

The East Boston low-service district includes a thickly settled residential district with a population of 56,230, together with much valuable wharf property along the water front. For the past forty years this district has been dependent for its water supply upon two mains which are laid under the bed of Chelsea Creek, a tidal arm of the ocean separating East Boston from the mainland of Chelsea. The creek at the location where the pipes are laid is about 1,500 feet wide at high water, while the low-water channel is about 300 feet wide. At the channel the pipes are buried several feet below the bed of the creek, but on the flats on either side the pipes are supported on piles just above the surface of the mud, and are exposed twice each day at low tide.

For the purpose of guarding against the interruption of the supply to the district by the breaking of these mains, a 36-inch main is now being laid in a different location. The new main connects

with existing 20-inch and 24-inch mains in Marginal Street, Chelsea, extends along the northerly shore of the creek about 3,800 feet to a point near the Chelsea Street Bridge leading to East Boston, where it turns easterly and crosses under the channel through a tunnel 504 feet long to the East Boston shore.

The new main is 30 inches in diameter for a distance of 729 feet from the connection with the old mains in Marginal Street to the corner of Shawmut and Essex streets. At this point the size of the pipe is increased to 36 inches in diameter, and a 36-inch branch is placed for future connection with the 42-inch main in Broadway, Chelsea. The 36-inch main extends easterly from this point through Essex and Highland streets and Congress Avenue, Marginal Street and Eastern Avenue to the Chelsea shaft of the tunnel under Chelsea Creek, a distance of 3,110 feet.

On account of the unstable nature of the ground the pipes are supported at the easterly end of this line for a distance of 1,700 feet upon a pile foundation, consisting of bents of 2 spruce piles capped with 10-inch x 10-inch spruce timber, the bents being spaced about 6 feet apart.

A contract for laying a portion of the pipe line in Chelsea was made with Michael Russo on August 10. Work was begun on August 15, and the contract was finished on December 8, at a cost of \$13,086.10.

At the crossing of Chelsea Creek a tunnel 504 feet long has been constructed under pneumatic pressure.

The tunnel section includes a vertical shaft at each side of the creek, 9 feet 4 inches outside diameter, with the top at elevation 14 on the Chelsea shore and at elevation 10 on the East Boston shore. The horizontal section of the tunnel, joining the shafts, is 400 feet in length, 8 feet 2 inches outside diameter, with the top 36 feet below mean low water at the Chelsea end, and is located about 25 feet down-stream from the westerly side line of the Chelsea Street Bridge. The shafts were constructed with 12-inch brick walls and the horizontal portion of the tunnel with 8-inch brick walls. The Chelsea shaft rises about 12 feet above the bed of the creek, and is protected by a steel casing which extends about 13 feet into the silt bottom of the creek. The East Boston shaft was sunk through the earth filling

back of the masonry sea wall, and is protected by a steel casing for a distance of 8 feet below the top. The axis of the horizontal section of the 36-inch pipe which is laid in the tunnel is 40 feet below Boston City Base at the Chelsea shaft.

The pipes are laid with a $\frac{1}{2}$ -inch opening between the end of the spigot and the bottom of the socket, and the joints are run solid with lead and calked both inside and outside after the pipe is laid. After the tunnel was excavated and lined the air pressure was removed, the 36-inch pipes are now being laid through the tunnel and the space between the pipes and the sides of the tunnel and shafts is being filled solid with Portland cement concrete. The tunnel section of the work is being done by day labor under the charge of Charles A. Haskin as superintendent.

The steam plant for operating the air compressors, hoists and electric lighting plant was set up on the Chelsea shore of the creek during the latter part of July, and the work of sinking the shaft was begun during the week ending August 13. After August 21, when the air lock was in place, the work was carried on continuously during twenty-four hours per day, with three shifts. While excavating the mud and silt just below the bed of the creek some inconvenience was experienced on account of gas, which entered the shaft and affected the eyes of the workmen.

The work of excavating and lining the shaft was completed about September 1. An air lock was then built at the entrance to the horizontal portion of the tunnel, and the small lock which had been used for sinking the shaft was removed. The excavation and lining of the horizontal portion of the tunnel progressed at the rate of about 5 feet per day. The air pressure maintained varied from 14 to 23 pounds per square inch, according to the stage of the tide in the creek above.

On October 13 a blow-out occurred about 150 feet from the Chelsea shaft at a point where a pile had been removed. As a result, the tunnel was flooded with water to a depth of about 4 feet. After the hole was stopped the water was pumped out, and the work proceeded without further mishap.

On the East Boston side of the creek the material excavated was hardpan containing boulders, which required some blasting, so that

the rate of progress was less than it had been in the sand and clay on the Chelsea side of the creek. A 2½-inch steel pipe was driven, during the week ending November 12, on the centre line of the tunnel near the East Boston end, from the surface of the ground to the centre of the tunnel, for use in supplying compressed air for sinking the East Boston shaft.

Work in the tunnel was discontinued on November 17, when steel sections of the East Boston shaft and the hoisting engine were set up on the East Boston side of the creek. On November 18 the work of excavating the East Boston shaft was begun, and on November 24 air pressure was applied.

An opening was made from the bottom of the shaft into the tunnel on December 3. All excavation and the brick lining for the tunnel were completed on December 6, and the air pressure was removed on the morning of December 9. A total of 104 linear feet of shaft and 400 feet of tunnel were built. The tunnel was cleaned out and plastered, and, after calking a few small leaks, was substantially water tight. At the end of the year 46.5 feet of 36-inch pipe had been laid in the East Boston shaft and the concrete masonry had been completed for a length of 38 feet. In the tunnel 160 feet of 36-inch pipe had been laid and the concrete masonry had been completed for a length of 157 feet.

The force employed on this work while working continuously under air pressure averaged about 15 men for each of the three shifts. After the air pressure was removed the work was carried on with three shifts working six days per week, the force employed averaging about 16 men per shift.

A 20-inch Venturi meter with 8-inch throat was installed by the maintenance force at the end of the line in East Boston, where connection was made with the Boston Water Works 30-inch main.

The cost of the work done on this new main to the end of the year was as follows:—

Section 37.

| | |
|---|-------------------|
| Pipes, valves and special castings, | \$22,092 42 |
| Laying pipes, including pipe-laying materials and earth excavation, | 6,830 90 |
| Pile driving and timber foundation, | 3,533 08 |
| Valve chambers and concrete backing for curves, . | 579 00 |
| Work in connection with changes in underground structures, | 2,357 71 |
| Additional expenses, | 1,417 48 |
| | ————— \$36,810 59 |

Section 38.

| | |
|--|--------------------|
| Pipes and special castings, | \$1,656 27 |
| Day work, labor, | 16,607 20 |
| Day work, supplies and expenses, | 14,977 03 |
| Additional expenses, | 738 04 |
| | ————— 33,978 54 |
| Engineering and preliminary, sections 37 and 38, . | 4,167 63 |
| Total, | ————— \$74,956 76 |

PUMPING ENGINE FOR SOUTHERN HIGH SERVICE.

A contract for building and erecting a triple expansion, crank and fly-wheel engine, having a capacity of 40,000,000 gallons in twenty-four hours, was made with the Holly Manufacturing Company of Buffalo, on September 21, 1909, and the construction of the engine was begun at the shops of the contractor in the latter part of that year. The first shipment of parts of the engine arrived at the pumping station in the latter part of August, 1910, and the work of erection has been in progress since that date. At the close of the year the main parts of the engine were nearly all in place, and it appears probable that the engine will be ready for service on March 21, 1911, as specified in the contract.

This engine is to be used for pumping water for the southern high-service district, but it is located in the low-service station in space which was originally designed to be used for engines pumping to the highest portions of Newton, Brookline and West Roxbury.

On April 29 a contract was made with the Robb-Mumford Boiler Company of South Framingham for furnishing two vertical fire-tube boilers from designs made by F. W. Dean of Boston, mechanical

engineer. One of these boilers was delivered at the pumping station on December 29 and the other will be delivered early in January. Each boiler is of 300 nominal horse power, 9 feet $1\frac{7}{8}$ inches in diameter, and contains 484 No. 12 gage, 2-inch charcoal iron tubes 15 feet long.

A contract for constructing and erecting a fuel economizer, containing 144 cast-iron tubes 4 inches in diameter, was made on October 11 with the B. F. Sturtevant Company of Hyde Park for the sum of \$1,740. The economizer has been delivered at the station and is now being erected.

Grates for use with the boilers are to be furnished by the New England Roller Grate Company for \$225 each.

A steel plate smoke flue, to connect the new boilers with the economizer and chimney, has been ordered from the B. F. Sturtevant Company for the sum of \$536.

The work of building the concrete foundations for the engine and boilers, constructing a valve chamber 38 feet x 9 feet at the front of the pumping station to receive two 36-inch hydraulic lift valves, cutting out the opening in the engine room floor to receive the engine and the openings in the concrete foundation walls for the suction and delivery mains, has been done by the maintenance force of the department.

The foundation for the engine was built in June and consists of a block of concrete masonry 33 feet 8 inches long, 21 feet 8 inches wide and 7 feet 6 inches deep. The concrete rests upon a clayey hardpan. The iron bolts securing the engine to this foundation are attached to cast-iron washers 18 inches square, embedded in the concrete 5 feet 11 inches from the top of the foundation. The concrete was mixed in the proportion of 1 part cement, 3 parts sand and 6 parts broken stone, and large pieces of broken concrete and rock from the excavation were embedded in the foundation.

A foundation was also built for one of the boilers, that for the other having been constructed when the pumping station was built. This foundation was carried 13 feet 2 inches below the boiler room floor. The concrete was mixed in the proportion of 1 part cement, 6 parts sand and 12 parts broken stone for 6 feet above the bottom, and the upper 7 feet was made of 1 part cement, 2 parts sand and 6 parts stone.

HYDRO-ELECTRIC PLANT.

Specifications were prepared in May for the sale of the electrical energy to be developed at the Wachusett Dam at Clinton, and bids for the energy were received on June 15, but it was not until September 14 that a contract was made with the Connecticut River Transmission Company for the purchase of all the energy for a term of five years from July 1, 1911.

Proposals for the construction and installation of the hydro-electric machinery required for the development of the power were received on November 9, and a contract has been made with the S. Morgan Smith Company of York, Pa., for installing both the hydraulic turbines and the electric generators. The generators and other electrical equipment will be furnished under a subcontract by the Westinghouse Electric & Manufacturing Company of Pittsburgh, Pa.

A contract for furnishing a traveling crane for use in erecting and maintaining the machinery has been made with the Niles-Bement-Pond Company of Boston, and a contract for furnishing four 48-inch hydraulic lift valves has been awarded to the Fairbanks Company of Boston.

The completed plant is to include four 1,200 horse power hydraulic turbine units of the spiral case, horizontal shaft type, each directly coupled to a 1,000-kilowatt, 60-cycle, 3-phase, 13,800-volt, alternating current generator, together with two 90 horse power horizontal shaft turbines, each directly coupled to a 60-kilowatt direct current, 125-volt generator, to be used in exciting the main generators. It is expected that this plant will be completed in readiness for operation by July 1 of the coming year.

MISCELLANEOUS CONSTRUCTION.

The Coffin Valve Company, under a contract made May 17, has furnished five 36-inch hydraulic lift valves for \$1,272 each, for use in connection with the new pumping engine at Chestnut Hill, also seven 24-inch and two 16-inch screw lift valves for use with the pipe lines. Fourteen sets of steelwork for covering valve chambers have

been furnished by the James Russell Boiler Works for the sum of \$690, and four steel chambers for Venturi meter registers have been furnished by the Daniel Russell Boiler Works for \$175 each.

ENGINEERING.

The work of the engineering force in connection with construction has included the preparation of plans and specifications, and the superintendence of work which has been in progress under 25 separate contracts, aggregating about \$700,000. The principal items of work covered by these contracts have been the 60-inch pipe line and tunnel in Newton; the new pumping engine, boilers and accessories at the Chestnut Hill pumping station; the 36-inch pipe line and tunnel from Chelsea to East Boston; pipe lines in Arlington and Lynn, and a hydro-electric power plant at the Wachusett Dam. During the year investigations have been made and estimates prepared relative to furnishing a supply of water from the Metropolitan Works to the towns of Peabody, Wakefield and Hyde Park.

MAINTENANCE.

RAINFALL AND YIELD.

The rainfall on the Wachusett watershed was 37.85 inches and on the Sudbury watershed 35.64 inches. In each case the amount is the mean of observations made at four stations. The rainfall for the past year on the Sudbury watershed has been less than that in any previous year during the thirty-six years covered by the records, with the exception of 1883, when it was 32.78 inches, and the rainfall of the past three years has been but 113.54 inches, which is less than that for any corresponding length of time since the records were commenced.

The daily average yield of the Wachusett watershed was but 828,000 gallons per square mile per day, which is less than any previous record, and 29 per cent. less than the average yield during the previous thirteen years. The average daily yield per square mile during the last six months of the year was but 201,000 gallons, or 16 per cent. below the lowest previous record for the watershed, and 65 per cent. below the average yield of the driest six months during the past fourteen years.

Statistics relating to the rainfall and yield of watersheds may be found in Appendix No. 2, tables Nos. 1 to 8.

STORAGE RESERVOIRS.

The quantity stored in all the storage reservoirs on January 1, 1910, was 62,101,500,000 gallons. There was a loss of 543,400,000 gallons during the first five days of the year, after which time there was a practically continuous gain until the first of April, when the quantity stored in all the reservoirs was 77,692,400,000 gallons. The quantity stored was reduced to 76,719,700,000 gallons on April 18, after which time it was increased until May 10, when it was 77,826,500,000 gallons. It fell to 76,585,000,000 gallons on June 5, and rose to 77,676,600,000 gallons on June 19, after which time there was a practically continuous loss of storage until the end of the year.

The following table gives the quantity of water stored in the storage reservoirs at the beginning of each month:—

Quantity of Water stored in Wachusett Reservoir, and in Reservoirs on Sudbury and Cochituate Watersheds, at the Beginning of Each Month.

| DATE. | In Wachusett Reservoir (Gallons). | In Sudbury Reservoir and Framingham Reservoir No. 3 (Gallons). | In All Other Storage Reservoirs (Gallons). | Total (Gallons). |
|------------------------|--|---|---|---------------------|
| 1910. | | | | |
| January 1, | 48,667,800,000 | 7,806,400,000 | 5,627,300,000 | 62,101,500,000 |
| February 1, | 52,256,200,000 | 7,857,400,000 | 6,258,900,000 | 66,372,500,000 |
| March 1, | 56,059,900,000 | 8,237,100,000 | 6,632,400,000 | 70,929,400,000 |
| April 1, | 63,252,000,000 | 8,046,800,000 | 6,393,600,000 | 77,692,400,000 |
| May 1, | 63,612,300,000 | 8,308,300,000 | 5,980,400,000 | 77,901,000,000 |
| June 1, | 62,932,400,000 | 7,933,900,000 | 6,196,300,000 | 77,062,600,000 |
| July 1, | 62,812,600,000 | 7,918,800,000 | 5,841,400,000 | 76,572,800,000 |
| August 1, | 59,194,200,000 | 7,962,900,000 | 5,685,300,000 | 72,842,400,000 |
| September 1, | 56,136,200,000 | 7,906,200,000 | 5,611,500,000 | 69,653,900,000 |
| October 1, | 53,360,500,000 | 7,831,100,000 | 5,665,700,000 | 66,857,300,000 |
| November 1, | 50,146,000,000 | 7,761,200,000 | 5,613,700,000 | 63,520,900,000 |
| December 1, | 48,175,400,000 | 7,808,500,000 | 5,700,700,000 | 61,684,600,000 |
| 1911. | | | | |
| January 1, | 45,610,400,000 | 7,890,400,000 | 5,826,200,000 | 59,327,000,000 |

Wachusett Reservoir and Dam.—At the beginning of the year the water in this reservoir was 12.91 feet below high-water mark, and the reservoir contained 48,667,800,000 gallons of water. The low-water mark of the early part of the year was on January 6, when the elevation of the reservoir was 381.70. After January 18 there was an almost continuous rise in the elevation of the water level of the reservoir until about April 1, when it was 393.72, or 1.28 feet below high-water mark. From this time until the latter part of June the reservoir surface remained at about the same elevation, the highest point being reached on May 8, when it was 394.25. After June 20 the reservoir surface lowered at the rate of a little more than 2 feet per month until the end of the year, when it stood at elevation 379.35, and contained 45,610,400,000 gallons of water, showing a net loss in storage during the year of 3,057,400,000 gallons.

The average daily quantity discharged from the reservoir into the river, in accordance with the requirements of section 4 of chapter 488 of the Acts of the year 1895, was 2,106,000 gallons per day.

As in previous years, the action of the waves on the shores of the reservoir has made necessary the removal of soil, in order to prevent its being washed into the reservoir. Between Hastings Cove in Boylston and Pine Hill in West Boylston, on the south shore, and along the north shore at Beaman Hill in West Boylston, the soil has been removed at points where necessary for a total distance of 5,526 feet, in widths varying from 10 to 25 feet. The aggregate area from which soil was removed was 1.75 acres, as compared with 1.46 acres in 1909. The amount expended for this work was \$907.29.

The action of the flood waters during the spring washed out the gravel bank which formed the easterly shore at the head of the Stillwater Basin. For a distance of 300 feet the bank has been regraded and reinforced with riprap formed with stones and gravel taken from the bed of the basin. The amount expended for this work was \$258.36.

The riprap on the easterly shore of the reservoir immediately above the dam has been repaired and reinforced with heavier stones for a distance of 1,250 feet, at a cost of \$115.16.

The paving at the outlet of the culvert which carries a small brook under Beaman Street into the Stillwater Basin has been relaid where damaged by the wearing away of the shore.

Tree stumps, roots, logs and miscellaneous débris brought into the reservoir by the flood waters in the spring, or unearthed by wave action on the shores, have been collected and burned.

Two pot holes, located near the westerly end of the North Dike, between the Clinton and West Boylston highway and the Worcester, Nashua & Portland Railroad, which became stagnant pools when the reservoir was full, have been improved in appearance, one by filling with earth to a level about one foot above high water in the reservoir and the other by cleaning the shores.

The standing and rowen grass on about 350 acres of land was sold for \$2,605.75. About 6.4 acres of grass land below the dam and 17.6 acres on the back slope of the easterly portion of the North Dike have been fertilized with 620 cubic yards of sludge collected from the settling tanks at the Clinton sewerage filter-beds. The cost of hauling and spreading this material was \$643.82.

The motor scow, which was built in 1909, has been used nearly every day, when the reservoir was not covered with ice, for transporting men, tools and materials in connection with the maintenance work, and has given excellent satisfaction.

The structures and grounds at the dam are in good condition. The outside and inside woodwork of both the upper and lower gate-chambers, the iron fences and railing on and about the dam, and the cast-iron and steel flashboard supports on the dam have been painted. A fountain has been installed in the pool below the dam, from which is discharged a portion of the water which the law requires shall be discharged into the river, thus adding a beautifying feature to the grounds.

The old dam at the outlet of Middle Waushacum Pond has been replaced with a concrete structure $26\frac{1}{2}$ feet long and 8 feet high, having a spillway 12 feet long fitted to receive stop-planks, and a 3 foot by $3\frac{1}{2}$ foot sluiceway fitted with a sluice gate.

The brook channel below this dam has been straightened, cleaned and improved for a distance of about 375 feet.

All the buildings at the storage yard near the Wachusett Dam, also the exterior of six houses owned by the Board located near the Clinton sewerage filter-beds, have been given two coats of paint.

Sudbury Reservoir. — All the water supplied to the Metropolitan District from the Wachusett Reservoir passes through this reservoir,

and its level is controlled by the manipulation of the gates controlling the flow through the Wachusett Aqueduct. The surface of the reservoir did not fall below the crest of the dam during the year, and all the water drawn from this reservoir into Framingham Reservoir No. 3 passed over the crest of the dam, except from April 15 to May 7, when the flashboards were on the whole length of the crest and the water was drawn through one of the waste gates.

The Bigelow house on Farm Street, Marlborough, occupied by one of the section men, has been repaired and painted. In order to obtain a permanent supply of water for the use of the section man living in the Cratty house, at Fayville, a well has been dug near the shore of the reservoir and connected with the house by a 1½-inch cement-lined pipe 215 feet in length. Some grading has been done on the road, following the north shore of the reservoir, from the dam around Pine Hill to Parmenter Street, and two culverts have been constructed in connection with this work. The reservoir and grounds have received the customary care and attention and are in good condition.

Framingham Reservoir No. 3.—The water in this reservoir was maintained within about 2 feet of the stone crest of the overflow. Some water was wasted into Framingham Reservoir No. 1 during the first three days of March, and also during the latter part of March and the first part of April.

Seven horizontal joints and a portion of the vertical joints in the face of the overflow of the dam, and ten horizontal and twenty-eight vertical joints on the down-stream face of the gate-house over the 48-inch pipes leading to Framingham Dam No. 1, have been cut out and repointed with Portland cement mortar. The mortar in many of the joints was found to be disintegrated to a considerable depth, necessitating cutting out the joints to depths of from 8 to 18 inches.

The entrance driveway at the dam has been extended to the new location of Worcester Street. The area between the old and new location of the street has been graded and covered with loam, and a gravel sidewalk has been built bordering on the street.

Framingham Reservoirs Nos. 1 and 2.—No water was drawn from these reservoirs during the year for the use of the Metropolitan District.

Ashland, Hopkinton and Whitehall Reservoirs.—These reservoirs

have not been drawn upon for the supply of the District during the year, and have remained at or near high-water mark. The grounds have received the usual care and are in good condition. The attendant's house at Hopkinton Reservoir has been repaired and the exterior painted. At Whitehall Reservoir the upper portion of the temporary dam built by the city of Boston in 1897, for the purpose of providing additional storage, has been removed, as it had become badly decayed and is no longer required.

Farm Pond. — No water was drawn from the pond for use in the Metropolitan District; none was wasted from the pond and none run into it from the Sudbury River. The town of Framingham drew the greater portion of its supply from the filter-gallery alongside the pond, but during 258 days of the year drew a portion of its supply directly from the Sudbury Aqueduct. The total quantity used in the town was 228,700,000 gallons, of which 38,100,000 gallons were drawn directly from the Sudbury Aqueduct.

Lake Cochituate. — The water in the lake was at elevation 138.76, or 5.6 feet below high water, at the beginning of the year. It rose to elevation 143.33 on February 10, when the waste gate was opened and the water prevented from rising. About the middle of April the quantity wasting was increased, and the lake surface lowered about 2 feet, and in the latter part of June and early in July the lake was lowered about 18 inches more, to elevation 139.50, for the purpose of facilitating the construction of a drainage system near the lake. The water was maintained at this elevation until the first of November, after which time it rose slowly and stood at elevation 141.17 at the end of the year. No water was drawn from the lake for the use of the Metropolitan District during the year.

The coping of the retaining wall bordering the driveway from Lake Avenue to the effluent gate-house, a distance of about 700 feet, has been reset, and the upper part of the retaining wall along Lake Avenue, for a distance of 400 feet west of the entrance driveway, relaid. The iron and wood work at the outlet dam, and the exterior of the roof and ironwork in the interior of the effluent gate-house, have been painted.

A four-strand wire fence, 281 feet long, has been built on the line between property of Edward Hammond and the Commonwealth on the east side of the lake, near Camp Tray. Twenty-nine standard

land bounds have been set to define land of the Commonwealth along Course Brook north of Speene Street.

Considerable work was done during the winter months in cleaning up woodland around the lake by removing dead and broken limbs, cutting brush, thinning out trees, and in clearing a strip from 4 to 5 feet in width through the woods along property lines.

DIVERSION OF SURFACE DRAINAGE OF THE VILLAGE OF COCHITUATE, FROM LAKE COCHITUATE INTO THE SUDBURY RIVER.

The surface drainage from an area of 140 acres now draining through Snake Brook into Lake Cochituate, on which there is a population of 707, is to be diverted into a system of open and covered drains, by which it is to be carried outside the watershed and discharged into Bannister's Brook. The outlet of the system is at an old mill-pond located north of the County Road and west of Speene Street, in Framingham. The open channel extends southerly from this point along Bannister's Brook, crossing the County Road, then turning easterly, following an old channel known as Richardson's drain, crossing Speene Street near the Natick-Framingham boundary line and the Saxonville Branch of the Boston & Albany Railroad, through land of the Commonwealth to a point near Lake Avenue in Natick, 400 feet west of the culvert connecting the northern and middle divisions of Lake Cochituate.

The length of this open channel is 5,958 feet, including 82 feet of covered concrete culvert at two street crossings. The channel is 12 inches wide at the bottom, with side slopes of 2 horizontal to 1 vertical, and is constructed with a plank bottom formed by spiking two 2-inch x 7-inch spruce planks side by side on 3-inch x 4-inch sills, 2 feet long, spaced 4 feet on centres, with side pieces of 6-inch x 6-inch spruce cut on the diagonal and rabbetted so as to lay 1 inch over the bottom planks. These side pieces form a footing for a strip of cobblestone paving 1½ feet wide on the slope, excepting at the outside of all curves, where the paving is 4½ feet wide. The slopes for a distance of 3 feet above the paving are covered with coarse gravel, excepting at the outside of curves.

The concrete-covered drain extends from the upper end of the open channel through Lake Avenue, in Natick, Pond Street, in Wayland, and land of the Commonwealth on the southerly side of Pond Street,

to Hammond's Brook, a distance of 3,454 feet. This drain is 36 inches wide x 33 inches high, and is constructed of Portland cement concrete mixed in the proportion of 1 part cement, $2\frac{1}{2}$ parts sand and 5 parts gravel.

At the crossing of the culvert connecting the northerly and middle divisions of Lake Cochituate a 36-inch cast-iron pipe is used in place of the concrete structure. This pipe was laid by the maintenance force in 1909, in order to take advantage of the unusually low level of the water in the lake.

A 24-inch vitrified pipe extends from the inlet chamber at Hammond's Brook through land of the Commonwealth, a distance of 957 feet, to Main Street, in Wayland. Nine manholes were built on the line of the concrete and pipe drains and 14 catch basins were built to receive the surface drainage at different points. In connection with the catch basins there were laid 167.5 feet of 18-inch and 351.4 feet of 12-inch vitrified pipe.

Contract work was begun July 12, the open channel was completed on December 3, and at the close of the year about two weeks' work remained to complete the drains in readiness for use. The average force employed by the contractor on the work was 64 men and 7 horses. The largest force employed was during the week ending September 10, when 134 men and 10 horses were at work.

The value of the work done under this contract to December 31 was \$30,674.52, and the total cost of the whole work will be about \$32,000.

SOURCES FROM WHICH WATER FOR THE SUPPLY OF THE METROPOLITAN DISTRICT HAS BEEN TAKEN.

An average of 103,146,200 gallons of water per day was drawn from the Wachusett Reservoir through the Wachusett Aqueduct into the Sudbury Reservoir. For the use of the Metropolitan District an average of 28,974,000 gallons per day was drawn from the Sudbury Reservoir through the Weston Aqueduct and an average of 85,033,000 gallons per day from Framingham Reservoir No. 3 through the Sudbury Aqueduct.

The drainage area of Spot Pond furnished 57,000 gallons of water per day.

AQUEDUCTS.

The *Wachusett Aqueduct* was in use 8,163 hours and 20 minutes, equivalent to 340.1 days, during the year. The aqueduct was not cleaned during the year.

The *Sudbury Aqueduct* was in continuous service the entire year, the daily flow to Chestnut Hill Reservoir averaging 85,033,000 gallons. The joints in the brick masonry and in the sandstone trimmings of the superstructures of Bacon's and Fuller's waste-weirs have been repointed with Portland cement mortar, also the joints in the stone masonry of the culverts numbered 16, 34, 39, 40 and 41. The joints in the masonry substructure of Clark's waste-weir and of the stone walls on both sides of the channel leading to Culvert No. 34 were also repointed.

At Echo Bridge, over the Charles River, the face of the ledge on the east side of the river at the foot of the large arch had commenced to disintegrate, and thus render unsafe the supports for the platform used by the public when listening to the echo. In order to prevent further disintegration of the rock a rubble wall about 5 feet high, with an average thickness of $3\frac{1}{2}$ feet at the bottom, has been built, covering the whole face of the ledge under the arch. About 13 cubic yards of material were used in the construction of this wall.

The leakage through joints and cracks in the masonry of this bridge is increasing from year to year, due to the gradual widening of the cracks by temperature changes and the action of ice during the winter, and extensive repairs similar to those made a few years ago at the Waban Bridge will soon be required.

The exterior of the store-house near the west siphon chamber, the floor grating in Fuller's waste-weir, the iron railing and roof flashing at the east siphon chamber, the railings, beams and other ironwork in the stairways leading to the top of Echo Bridge and to the platform under the large arch, and the manhole covers along the aqueduct line have been painted, and the stairways on the embankments of the east and west siphon chambers and on that leading to the top of Echo Bridge have been oiled. A new right-of-way has been acquired from Eliot Street, in Natick, to Bacon's waste-weir, to be used in place of the old inconvenient right-of-way from Woodland Street.

No water was drawn through the *Cochituate Aqueduct* for the use of the Metropolitan District during the year. The joints in the stone masonry of the following culverts have been cut out and repointed: Culvert west of Croton Street, in Wellesley; culvert east of Washington Street, at Newton Lower Falls; culvert on the west side of Woodward Street, in Newton, and the first culvert east of Chestnut Street, in Newton.

The *Weston Aqueduct* was in continuous service throughout the year, the daily average flow being 28,974,000 gallons. The aqueduct was not cleaned during the year. The siphon pipe over the Sudbury River, the iron and wood work in the gaging and siphon chambers and the manhole covers have been painted. At several points along the line of the aqueduct the slopes of the embankments have been graded and seeded.

PUMPING STATIONS.

Seventy-four per cent. of the water supplied to the Metropolitan District has been pumped at the two stations at Chestnut Hill Reservoir, and the remainder has been delivered by gravity. The total quantity pumped at all the stations was 34,108,790,000 gallons, which was 4.62 per cent. less than during the preceding year. The cost of operating the stations was \$101,996.34, equivalent to \$2.99 per million gallons pumped, which was almost exactly the same as the corresponding amount for the year 1909. The average cost of raising 1,000,000 gallons of water 1 foot high at all the stations was \$0.0342, which is slightly less than the cost during the previous year. Coal for use at the several stations has been purchased as follows: —

BY WHOM FURNISHED.

| | GROSS TONS. | | | | | Cost per Gross Ton, in Bins. ¹ |
|---|-------------------------------------|------------------------------------|--------------------|--------------------|-----------------------|--|
| | Chestnut Hill High-service Station. | Chestnut Hill Low-service Station. | Spot Pond Station. | Arlington Station. | West Roxbury Station. | |
| Gorman-Leonard Coal Company, bituminous, | 1,015.09 | - | - | - | - | \$4.09 |
| Gorman-Leonard Coal Company, bituminous, | - | 569.60 | - | - | - | 4.01 |
| Spring Coal Company, bituminous, | 2,787.74 | - | - | - | - | 3.96 |
| Spring Coal Company, bituminous, | - | 1,508.35 | - | - | - | 3.79 |
| C. W. Clafin & Co., buckwheat anthracite, | 208.78 | - | - | - | - | 2.80 |
| C. W. Clafin & Co., buckwheat anthracite, | 903.40 | - | - | - | - | 2.75 |
| C. W. Clafin & Co., buckwheat anthracite, | - | 115.92 | - | - | - | 2.62 |
| C. W. Clafin & Co., buckwheat anthracite, | - | 813.67 | - | - | - | 2.58 |
| New England Coal & Coke Company, bituminous. | - | - | 587.77 | - | - | 4.88 |
| New England Coal and Coke Company, bituminous. | - | - | 58.34 | - | - | 4.60 |
| Locke Coal Company, bituminous, | - | - | 90.07 | - | - | 4.60 |
| Locke Coal Company, screenings, | - | - | 149.06 | - | - | 2.50 |
| Joseph Butler, screenings, | - | - | 69.30 | - | - | 2.50 |
| New England Coal and Coke Company, bituminous. | - | - | - | 170.00 | - | 4.31 |
| New England Coal and Coke Company, bituminous. | - | - | - | 30.09 | - | 4.08 |
| New England Coal and Coke Company, bituminous. | - | - | - | 124.42 | - | 3.89 |
| Philadelphia and Reading Coal and Iron Company, screenings. | - | - | - | 117.50 | - | 2.68 |
| Metropolitan Coal Company, furnace, | - | - | - | - | 20.04 | 6.27 |
| Roxbury Coal Company, furnace, | - | - | - | - | 6.77 | 5.88 |
| Metropolitan Coal Company, pea, | - | - | - | - | 181.84 | 5.04 |
| Roxbury Coal Company, buckwheat anthracite, | - | - | - | - | 104.02 | 4.37 |
| Roxbury Coal Company, buckwheat anthracite, | - | - | - | - | 1.86 | 3.98 |
| Total gross tons, bituminous, | 3,802.83 | 2,077.95 | 736.18 | 324.51 | - | - |
| Total gross tons, anthracite, | 1,172.18 ² | 929.59 ² | - | - | 314.53 | - |
| Total gross tons, anthracite screenings, | - | - | 218.36 | 117.50 | - | - |
| Average price per gross ton, bituminous, | \$3.99 | \$3.85 | \$4.82 | \$4.13 | - | - |
| Average price per gross ton, anthracite, | 2.76 ² | 2.59 ² | - | - | \$4.91 | - |
| Average price per gross ton, anthracite screenings, | - | - | 2.50 | 2.68 | - | - |

¹ Includes cost of unloading coal from cars and all expenses incidental to storage of the coal.² Buckwheat.

The contracts which have been made for bituminous coal have specified that the coal should contain approximately 14,700 British thermal units per pound, 18 to 20 per cent. volatile matter, and not more than 7 per cent. of ash and 1 per cent. of sulphur. Payments for the coal are now made on the basis of the price bid, corrected for variations in heating value and per cent. of ash, as determined

by testing samples of the coal delivered, an addition being made in cases where the number of British thermal units exceeds 14,700 and a deduction when the number falls below 14,600. A deduction is also made when the moisture in the coal exceeds 3 per cent. These requirements are more stringent than those in force during previous years, and the quality of the coal now obtained is better than it was a few years ago.

The following table shows the results of tests made of coal burned at the Water Works pumping stations during the past year:—

| KIND OF COAL. | Number of Samples tested. | British Thermal Units. | Percentage of Volatile Matter. | Percentage of Ash. | Percentage of Moisture. |
|----------------|---------------------------|------------------------|--------------------------------|--------------------|-------------------------|
| Vulcan, | 58 | 14,474 | 20.95 | 8.16 | 2.54 |
| Beaver Run, | 26 | 14,722 | 17.40 | 6.70 | 3.15 |
| New River, | 7 | 14,867 | 21.18 | 5.27 | 1.83 |
| Pocahontas, | 6 | 14,879 | 19.55 | 5.16 | 2.33 |
| Georges Creek, | 6 | 14,469 | 18.88 | 7.71 | 2.59 |
| Davis, | 2 | 14,517 | 17.12 | 7.08 | 2.48 |
| Nan-ty-glo, | 1 | 14,982 | 21.56 | 5.14 | 3.24 |
| Carbon, | 1 | 14,268 | 18.10 | 9.24 | 4.17 |

Chestnut Hill High-service Station.

At this station water is pumped for use in the high-service district of Boston, the city of Quincy and the towns of Watertown, Belmont and Milton.

The following are the statistics relating to operations at this station:—

| | Engines Nos. 1 and 2. | Engine No. 3. | Engine No. 4. | Totals for Station. |
|--|-----------------------|---------------|---------------|---------------------|
| Total quantity pumped (million gallons), | 1,377.71 | 228.67 | 10,824.70 | 12,431.08 |
| Daily average quantity pumped (gallons), | 3,775,000 | 626,000 | 29,657,000 | 34,058,000 |
| Total coal used (pounds), | 2,168,024 | 247,119 | 8,467,877 | 10,883,020 |
| Gallons pumped per pound of coal, | 635.47 | 925.34 | 1,278.33 | 1,142.25 |
| Average lift (feet), | 119.67 | 129.88 | 130.58 | 129.38 |
| Cost of pumping:— | | | | |
| Labor, | \$4,005.32 | \$538.35 | \$16,990.32 | \$21,533.99 |
| Fuel, | 3,605.96 | 411.62 | 14,209.11 | 18,226.69 |
| Repairs, | 337.91 | 42.36 | 1,336.95 | 1,717.22 |
| Oil, waste and packing, | 99.32 | 13.35 | 421.33 | 534.00 |
| Small supplies, | 66.32 | 8.91 | 281.31 | 356.54 |
| Totals, | \$8,114.83 | \$1,014.59 | \$33,239.02 | \$42,368.44 |
| Cost per million gallons pumped, | \$5.8900 | \$4.4370 | \$3.0710 | \$3.4080 |
| Cost per million gallons raised 1 foot high, | .0492 | .0342 | .0235 | .0263 |

The daily average quantity pumped was less than the corresponding quantity for the previous year by 2,750,000 gallons, or 7.47 per cent.

The cost of operating the station was \$4,110.21 less than for the previous year, due largely to the reduction in the quantity pumped.

Chestnut Hill Low-service Station.

The daily average quantity pumped at this station was less by 2,161,000 gallons, or 4.11 per cent., than the corresponding amount for the previous year.

The following are the statistics relating to operations at this station:—

| | Engines Nos. 5, 6 and 7. |
|--|-----------------------------|
| Total quantity pumped (gallons), | 18,394,520,000 |
| Daily average quantity pumped (gallons), | 50,396,000 |
| Total coal used (pounds), | 7,122,390 |
| Gallons pumped per pound of coal, | 2,582.63 |
| Average lift (feet), | 49.08 |
| Cost of pumping:— | |
| Labor, | \$19,675 97 |
| Fuel, | 10,952 56 |
| Repairs, | 1,525 11 |
| Oil, waste and packing, | 472 54 |
| Small supplies, | 363 89 |
| Total for station, | |
| | <u>\$32,990 07</u> |
| Cost per million gallons pumped, | \$1.7930 |
| Cost per million gallons raised 1 foot high, | .0365 |

The work of building foundations for the new engine and boilers which are being installed at this station has been in progress during the year. A description of this work will be found in this report under the head of "Construction."

Spot Pond Pumping Station.

The following are statistics relating to operations at this station:—

| | |
|--|---------------|
| Total quantity pumped (gallons), | 2,752,110,000 |
| Daily average quantity pumped (gallons), | 7,540,000 |
| Total coal used (pounds), | 2,413,914 |
| Gallons pumped per pound of coal, | 1,140.10 |
| Average lift (feet), | 130.92 |
| Engine No. 8 operated (hours), | 161 |
| Engine No. 9 operated (hours), | 3.218 |
| Quantity pumped by Engine No. 8 (gallons), | 70,130,000 |
| Quantity pumped by Engine No. 9 (gallons), | 2,681,980,000 |

| | |
|--|-------------|
| Cost of pumping:— | |
| Labor, | \$8,779 04 |
| Fuel, | 4,191 43 |
| Repairs, | 199 22 |
| Oil, waste and packing, | 249 39 |
| Small supplies, | 203 39 |
| Total for station, | \$13,622 47 |
| Cost per million gallons pumped, | \$4.9500 |
| Cost per million gallons raised 1 foot high, | .0378 |

The quantity of water pumped at this station was 2.2 per cent. greater, while the total cost of operating the station was \$426.39, or 3 per cent. less than during the previous year. The reduction in cost was due to the fact that but \$199.22 were expended for repairs during the past year, as compared with \$686.99 during 1909. The cost per million gallons pumped to the reservoir was \$4.95, as compared with \$5.216 in 1909.

Arlington Pumping Station.

At this station was pumped all the water supplied to the town of Lexington, to the high-service district of the town of Arlington and to a few houses in the town of Belmont.

The following are the statistics relating to operations at this station:—

| | |
|---|-------------|
| Total quantity pumped (gallons), | 282,530,000 |
| Daily average quantity pumped (gallons), | 774,000 |
| Total coal used (pounds), | 999,115 |
| Gallons pumped per pound of coal, | 282.78 |
| Average lift (feet), | 285 |
| Engine No. 10 operated (hours), | 6,295 |
| Engine No. 11 operated (hours), | 220 |
| Quantity pumped by Engine No. 10 (gallons), | 275,440,000 |
| Quantity pumped by Engine No. 11 (gallons), | 7,090,000 |

Cost of pumping:—

| | |
|--|------------|
| Labor, | \$5,029 26 |
| Fuel, | 1,658 48 |
| Repairs, | 294 29 |
| Oil, waste and packing, | 101 45 |
| Small supplies, | 300 04 |
| Total for station, | \$7,383 52 |
| Cost per million gallons pumped, | \$26.1340 |
| Cost per million gallons raised 1 foot high, | .0917 |

There was an increase of 17.08 per cent. in the quantity pumped, and a decrease of \$442.80, or 5.66 per cent., in the cost of operating the station, as compared with the previous year.

The efficiency of the plant has been improved by the installation of a feed-water heater which had been used previously at the Chestnut Hill station.

West Roxbury Pumping Station.

At this station water was pumped for supplying the higher portions of West Roxbury and Milton.

The following are the statistics relating to operations at this station:—

| | | |
|---|-----------|-------------|
| Total quantity pumped (gallons), | | 248,551,000 |
| Pumps operated 7,654 hours; average, 21 hours per day. | | |
| Daily average quantity of water pumped (gallons), | | 681,000 |
| Daily average quantity of coal consumed (pounds), | | 1,913 |
| Gallons pumped per pound of coal, | | 355.92 |
| Average lift (feet), | | 134 |
| Cost of pumping:— | | |
| Labor, | | \$3,775 22 |
| Fuel, | | 1,553 38 |
| Repairs, | | 211 87 |
| Oil, waste and packing, | | 41 06 |
| Small supplies, | | 50 31 |
| Total for station, | | |
| | | \$5,631 84 |
| Cost per million gallons pumped, | | \$22.6590 |
| Cost per million gallons raised 1 foot high, | | .1691 |

The quantity pumped was 18.95 per cent. greater while the cost of operating the station was less by \$744.63, or 11.68 per cent., than for the previous year. The cost per million gallons pumped was reduced from \$30.52 to \$22.66. This result was very largely due to the use of a fuel of lower cost and to the more efficient operation of the machinery.

CONSUMPTION OF WATER.

The daily average quantity of water consumed in the 18 municipalities supplied from the Metropolitan Water Works during the year 1910, as measured by Venturi meters, was 112,092,100 gallons, equal to 110 gallons per capita in the district supplied. In

addition to the above, 85,400 gallons daily were supplied to the United States Government reservation on Peddock's Island, and 16,500 gallons daily to a small portion of the town of Saugus. The daily average quantity supplied to the Metropolitan Water District, as determined by pump measurement and by the flow in the Weston Aqueduct, and the estimated yield of Spot Pond, was 113,880,000 gallons, equal to 111 gallons per inhabitant. The excess difference of 1,686,000 gallons per day between the quantity delivered by the aqueducts and that measured by meters to the several municipalities is due to difference in methods of measurement, to leakage from the Metropolitan Water Works reservoirs and pipes, and to the use of water at the Chestnut Hill and Spot Pond pumping stations.

The daily average consumption of water in each of the cities and towns supplied from the Metropolitan Works during the years 1909 and 1910, as measured by meters, was as follows:—

| | Estimated Population, 1910. | DAILY AVERAGE CONSUMPTION. | | | | | |
|-------------------|-----------------------------|----------------------------|----------------------------------|-------------|---------------------|----------------------|----------------------|
| | | 1909. | | 1910. | | Increase in Gallons. | Decrease in Gallons. |
| | | Gallons. | Gallons per Capita. ¹ | Gallons. | Gallons per Capita. | | |
| Boston, . . . | 674,400 | 94,029,900 | 143 | 87,346,700 | 130 | - | 6,683,200 |
| Somerville, . . . | 77,640 | 6,331,000 | 83 | 6,189,500 | 80 | - | 141,500 |
| Malden, . . . | 44,730 | 1,848,500 | 43 | 1,874,400 | 42 | 25,900 | - |
| Chelsea, . . . | 32,540 | 2,869,400 | 89 | 2,834,500 | 87 | - | 34,900 |
| Everett, . . . | 33,710 | 2,641,300 | 80 | 2,575,600 | 76 | - | 65,700 |
| Quincy, . . . | 32,870 | 2,919,000 | 91 | 2,891,900 | 88 | - | 27,100 |
| Medford, . . . | 23,330 | 1,732,300 | 77 | 1,422,400 | 61 | - | 309,900 |
| Melrose, . . . | 15,790 | 962,300 | 62 | 1,005,700 | 64 | 43,400 | - |
| Revere, . . . | 18,500 | 1,250,700 | 72 | 1,313,400 | 71 | 62,700 | - |
| Watertown, . . . | 12,960 | 755,300 | 60 | 880,800 | 68 | 125,500 | - |
| Arlington, . . . | 11,270 | 861,300 | 79 | 938,200 | 83 | 76,900 | - |
| Milton, . . . | 7,970 | 313,200 | 40 | 309,200 | 39 | - | 4,000 |
| Winthrop, . . . | 10,290 | 877,600 | 91 | 649,500 | 63 | - | 228,100 |
| Stoneham, . . . | 7,130 | 575,200 | 82 | 650,800 | 91 | 75,600 | - |
| Belmont, . . . | 5,600 | 310,100 | 58 | 329,500 | 59 | 19,400 | - |
| Lexington, . . . | 4,440 | 329,400 | 76 | 345,500 | 78 | 16,100 | - |
| Nahant, . . . | 2,100 | 124,400 | 60 | 121,700 | 58 | - | 2,700 |
| Swampscott, . . . | 6,960 | 388,200 | 56 | 412,800 | 59 | 24,600 | - |
| District, . . . | 1,022,230 | 119,119,100 | 119 | 112,092,100 | 110 | - | 7,027,000 |

¹ The populations for 1909 were revised after the Census of 1910 became available, and consequently the per capita figures differ from those published in 1909 report.

The consumption in the several districts was as follows:—

| | Gallons per Day. 1910. | Decrease (Gallons per Day.) | Percent- age of Decrease. |
|--|---------------------------|--------------------------------|---------------------------------|
| Southern low-service district, embracing the low-service district of Boston, with the exception of Charlestown and East Boston, | 44,667,600 | 3,668,000 | 7.59 |
| Northern low-service district, embracing the low-service districts of Somerville, Chelsea, Malden, Medford, Everett, Arlington, Charlestown and East Boston, | 26,032,400 | 499,100 | 1.88 |
| Southern high-service district, embracing the high-service districts of Boston, Quincy, Watertown, and portions of Belmont and Milton, | 32,644,400 | 2,985,000 | 8.38 |
| Northern high-service district, embracing Melrose, Revere, Winthrop, Swampscott, Nahant and Stoneham, and the high-service districts of Somerville, Chelsea, Malden, Medford, Everett and East Boston, | 7,292,600 | 101,200 | 1.37 |
| Southern extra high-service district, embracing the higher portions of West Roxbury and Milton, | 681,000 | 108,500 ¹ | 18.95 ¹ |
| Northern extra high-service district, embracing Lexington and the higher portions of Arlington and Belmont, | 774,100 | 117,800 ¹ | 17.95 ¹ |
| Totals, | 112,092,100 | 7,027,000 | 5.90 |

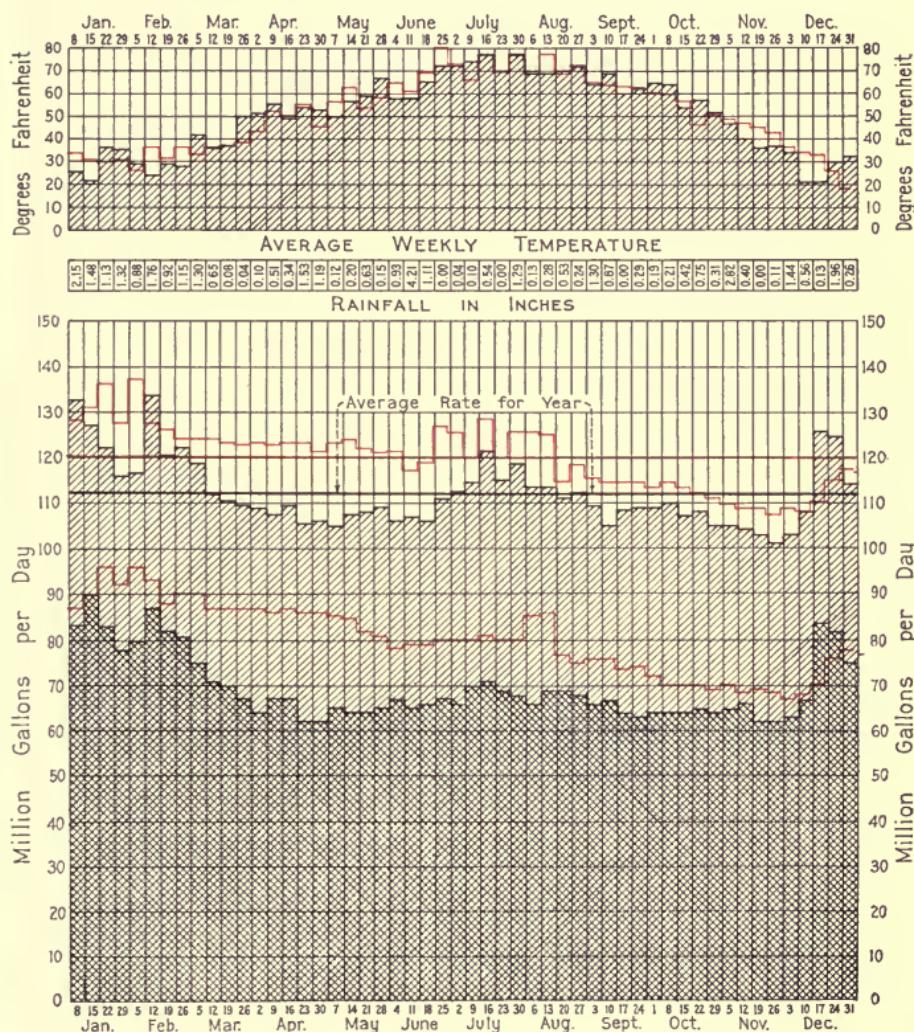
¹ Increase.

The daily average quantity of water used in the District was 13,332,100 gallons less than during the year 1908. In the cities of Boston and Medford and the town of Winthrop a large reduction in the use of water has been accomplished during the past year by the introduction of meters. The reduction in these places, together with Melrose, in which meters were introduced in 1906 and 1907, illustrates very forcibly the saving which has been accomplished largely by the introduction of meters:—

| CITY OR TOWN. | Popu- lation, 1910. | PER CAPITA CONSUMPTION (GALLONS). | | | Equiva- lent Saving in Gallons per Day. | METERS IN USE. | |
|-------------------|---------------------------|--------------------------------------|-------|---------------------------------|---|------------------|------------------|
| | | 1907. | 1910. | Reduction in Three Years. | | Jan. 1, 1907. | Jan. 1, 1910. |
| Boston, | 674,400 | 157 | 130 | 27 | 18,208,800 | 5,090 | 12,100 |
| Medford, | 23,330 | 105 | 61 | 44 | 1,026,520 | 449 | 2,594 |
| Melrose, | 15,790 | 118 | 64 | 54 | 852,660 | 132 | 3,510 |
| Winthrop, | 10,290 | 117 | 63 | 54 | 555,660 | 45 | 1,533 |
| Totals, | 723,810 | | | | 20,643,640 | 5,716 | 19,737 |

The diagram facing this page shows graphically the average daily consumption and the rate of consumption between the hours of 1 and 4 A.M. in the district supplied by the Metropolitan Works for

AVERAGE RATE OF CONSUMPTION
IN
METROPOLITAN WATER DISTRICT
AND
RAINFALL AND AVERAGE TEMPERATURE OF AIR AT CHESTNUT HILL RESERVOIR
FOR
EACH WEEK DURING 1910



Average Rate of Consumption for each week, thus.....
 " " " between 1 and 4 A.M. for each week, thus.....
 Averages in 1909 shown in Red.

each week during the years 1909 and 1910. The amount of rainfall and the average temperature for each week, as observed at the Chestnut Hill Reservoir, are also shown. It will be noted that an increase or decrease in the daily consumption from week to week is coincident with an almost equal reduction in the rate of use between midnight and 4 A.M., indicating that the increase or decrease is due to a waste of water which was continuous throughout the twenty-four hours, and not due to a reduction in use during the hours when the greatest use should take place. Although the consumption, as shown by the diagram, varied from 102,000,000 to 136,000,000 gallons per day during several weeks of the two years, the difference between the night rate and the average daily rate for the corresponding week is shown to have been between 40,000,000 and 45,000,000 gallons, indicating that the changes in consumption are due to changes in the amount wasted rather than in the amount used. In the city of Boston a reduction of 23 gallons per capita has been made in two years, but the fact that in some districts of the city the rate of consumption still remains very high is proof that the further introduction of meters and a careful inspection for leaks in street mains will undoubtedly result in a considerable further lowering of the per capita rate.

The use in the several districts into which Boston is subdivided for purposes of measurement was, in 1908 and 1910, as follows:—

| | Popula- tion, 1910. | DAILY AVERAGE CON- SUMPTION (GALLONS). | | GALLONS PER CAPITA. | |
|---|---------------------------|---|------------|------------------------|-------|
| | | 1908. | 1910. | 1908. | 1910. |
| Southern low-service includes business, residential and manufacturing districts in city proper, South Boston, Roxbury and Dorchester, | 350,110 | 51,313,600 | 44,667,600 | 148 | 128 |
| Southern high-service includes business and residential districts in city proper and residential districts in Roxbury, Dorchester and West Roxbury, | 211,100 | 30,112,400 | 27,077,600 | 158 | 128 |
| Charlestown includes greater portion of Charlestown, | 40,320 | 7,749,100 | 7,552,700 | 195 | 187 |
| East Boston includes all of East Boston except Breed's Island, | 56,230 | 7,278,300 | 6,172,600 | 140 | 110 |
| Brighton high-service, residential district, | 11,100 | 1,299,100 | 1,192,200 | 135 | 107 |
| West Roxbury high-service, residential district, | 5,010 | 599,600 | 655,500 | 131 | 131 |
| Breed's Island, residential district, | 530 | 27,200 | 28,500 | 60 | 54 |
| | 674,400 | 98,379,300 | 87,346,700 | 153 | 130 |

Metering of Service Pipes.

On December 31, 1910, the cities of Boston and Quincy and the town of Revere were the only municipalities which had not complied with chapter 524 of the Acts of 1907 relative to the metering of service pipes. This Act provides that on and after January 1, 1908, all cities and towns which derive their water from the Metropolitan Works shall equip all new service pipes with water meters, and shall also annually equip with meters 5 per cent. of the services which were unmetered on December 31, 1907. More than the required number were set in Boston during the past year, but there is still a deficiency in the total number from previous years.

The number of meters set in these municipalities during the past three years, compared with the number required by law, is as follows:—

| | NUMBER OF METERS REQUIRED BY LAW. | | | NUMBER OF METERS SET. | | |
|-------------------|--------------------------------------|---------------------|--------|-----------------------|---------------------|--------|
| | On Old Services. | On New Services. | Total. | On Old Services. | On New Services. | Total. |
| Boston, | 13,314 | 3,462 | 16,776 | 11,068 | 2,313 | 13,381 |
| Quincy, | 690 | 1,170 | 1,860 | 814 | 315 | 1,129 |
| Revere, | 414 | 527 | 941 | 379 | 348 | 727 |

The following table gives the statistics relative to the setting of meters and the number of service pipes and meters connected with the distributing pipes in the District on December 31, 1910:—

| CITY OR TOWN. | Number of Meters required to be set on Old Services Each Year. | METERS SET ON OLD SERVICES. | | | New Services installed, 1910. ¹ | New Services equipped with Meters, 1910. ¹ | Services in Use December 31, 1910. | Meters in use December 31, 1910. | Per Cent. of Services metered December 31, 1910. |
|----------------------|--|-----------------------------|-------|--------|--|---|------------------------------------|----------------------------------|--|
| | | 1908. | 1909. | 1910. | | | | | |
| | | | | | | | | | |
| Boston, | 4,438 | 84 | 5,503 | 5,481 | 1,134 | 1,134 | 93,780 | 18,720 | 19.96 |
| Somerville, | 411 | 732 | 621 | 501 | 149 | 227 | 12,149 | 5,810 | 47.82 |
| Malden, | 14 | 43 | 62 | 8 | 161 | 177 | 7,440 | 7,163 | 96.28 |
| Chelsea, | 240 | 198 | 756 | 779 | 105 | 105 | 4,790 | 3,082 | 64.34 |
| Everett, | 252 | 338 | 255 | 277 | 62 | 77 | 5,380 | 1,186 | 22.04 |
| Quincy, | 230 | 358 | 33 | 423 | 493 | 179 | 7,307 | 2,634 | 36.05 |
| Medford, | 179 | 857 | 927 | 1,555 | 149 | 149 | 4,550 | 4,296 | 94.42 |
| Melrose, | 119 | 2,432 | 135 | 7 | 79 | 263 | 3,583 | 3,777 | 100.00 |
| Revere, | 138 | 85 | 184 | 110 | 188 | 185 | 3,402 | 885 | 26.01 |
| Watertown, | - | - | - | - | 69 | 97 | 2,042 | 2,070 | 100.00 |
| Arlington, | 55 | 108 | 56 | 63 | 83 | 104 | 2,050 | 1,288 | 62.83 |
| Milton, | - | - | - | - | 74 | 74 | 1,454 | 1,454 | 100.00 |
| Winthrop, | 100 | 213 | 975 | 706 | 167 | 167 | 2,487 | 2,386 | 95.94 |
| Stoneham, | 65 | 116 | 225 | 186 | 21 | 21 | 1,467 | 635 | 43.29 |
| Belmont, | - | - | - | - | 63 | 63 | 909 | 909 | 100.00 |
| Lexington, | 32 | 113 | 70 | 56 | 57 | 57 | 836 | 475 | 56.82 |
| Nahant, | 16 | 30 | 40 | 26 | 20 | 22 | 532 | 227 | 42.67 |
| Swampscott, | 21 | 264 | 142 | 28 | 82 | 82 | 1,478 | 1,465 | 99.12 |
| Totals, | 6,310 | 5,971 | 9,984 | 10,206 | 3,156 | 3,183 | 155,636 | 58,462 | 37.56 |

¹ The number of new meters installed and the number of new services equipped with meters seldom agree exactly for the reason that service pipes are installed but meters are not set until the buildings are permanently occupied.

This table was first prepared for the annual report in accordance with the original returns received from the various municipalities. Revised returns received have caused some changes to be made, particularly in the figures applicable to the city of Boston.

At the end of the year 37.56 per cent. of all the service pipes in the District were metered, as compared with 28.35 per cent. at the beginning of the year. During the past year meters have been placed on a large number of the services in Medford and Winthrop, and at the end of the year there were 8 municipalities in which 94 to 100 per cent. of the services were metered.

QUALITY OF THE WATER.

The water in the Wachusett and Sudbury reservoirs and Framingham Reservoir No. 3, from which the entire supply of the Metropolitan District was drawn, has been almost entirely free from organisms causing objectionable tastes and odors. The examinations made by the State Board of Health, as well as those made in the laboratory of the Board, have shown that the water delivered in the District has had a lower color and less residue than in any previous year, and that in all respects its quality has compared very favorably with that supplied during previous years.

The growth of *Asterionella*, which gave the water an objectionable taste and odor for several months in 1909, was not present in sufficient quantity to be objectionable. There was a small growth of *Uroglena* in the water of Sudbury Reservoir, lasting about two weeks in April, which reappeared about the 10th of May and remained in decreasing quantity until the first of June. *Chlamydomonas* and *Dinobryon* were present in the Sudbury Reservoir during the latter half of the year, but never in sufficient quantity to cause trouble. Framingham Reservoir No. 3 contained the same organisms as the Sudbury Reservoir, in small numbers.

The weekly, biweekly and monthly collection and examination of samples of water from the several reservoirs, as well as from taps at several points in the Metropolitan District, have been continued as in previous years. There have been made 2,377 microscopical and 961 bacterial examinations.

The water in Framingham Reservoir No. 2 and in the Ashland, Hopkinton and Whitehall reservoirs was free from objectionable organisms throughout the year. The color of the water in these reservoirs varied from .84 to .116 during the early part of the year and from .38 to .48 during the last six months.

A growth of *Chlamydomonas* in Lake Cochituate has given the water in that reservoir a disagreeable odor during practically the entire year. Its average color was .26.

There have been small growths of *Uroglena* in all the distributing reservoirs in the Metropolitan District. The largest numbers were observed in Spot Pond in February and May, in Waban Hill Reservoir about the first of February and during the latter part of May and in Bear Hill Reservoir in May. Although faintly dis-

agreeable odors have been noted in the hot water as drawn from the taps, there has been neither noticeable taste nor odor in the cold water, and no complaints have been received from the water takers. The average color of the water delivered from the low-service taps was .18 and from the high-service taps .12.

The following table gives a comparison of the average results of the examinations of water from a tap in Boston for the years 1902 to 1910, inclusive:—

| | 1902. | 1903. | 1904. | 1905. | 1906. | 1907. | 1908. | 1909. | 1910. |
|--|--------|--------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| <i>State Board of Health Examinations.</i> | | | | | | | | | |
| <i>Color (Nessler standard),</i> | | | | | | | | | |
| Color (Nessler standard), | .26 | .25 | .23 ¹ | .24 ¹ | .24 ¹ | .22 ¹ | .19 ¹ | .18 ¹ | .14 ¹ |
| Total residue, | 3.93 | 3.98 | 3.93 | 3.86 | 3.86 | 3.83 | 3.50 | 3.46 | 3.05 |
| Loss on ignition, | 1.56 | 1.50 | 1.59 | 1.59 | 1.39 | 1.40 | 1.35 | 1.43 | 1.24 |
| Free ammonia, | .00016 | .00013 | .00023 | .00020 | .00018 | .00013 | .00011 | .00011 | .00013 |
| Albuminoid { total, | 0.0139 | 0.0125 | 0.0139 | 0.0145 | 0.0159 | 0.0129 | 0.0115 | 0.0128 | 0.0118 |
| ammonia, dissolved, | 0.0119 | 0.0110 | 0.0121 | 0.0124 | 0.0134 | 0.0109 | 0.0092 | 0.0103 | 0.0102 |
| Chlorine, suspended, | 0.0020 | 0.0015 | 0.0018 | 0.0021 | 0.0025 | 0.0020 | 0.0024 | 0.0025 | 0.0016 |
| Chlorine, . | 0.29 | 0.30 | 0.34 | 0.35 | 0.34 | 0.33 | 0.33 | 0.28 | 0.28 |
| Nitrogen as nitrates, | 0.0092 | 0.0142 | 0.0110 | 0.0083 | 0.0054 | 0.0068 | 0.0092 | 0.0034 | 0.0030 |
| Nitrogen as nitrites, | .00001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0000 | 0.0000 |
| Oxygen consumed, | 0.40 | 0.39 | 0.37 | 0.35 | 0.36 | 0.32 | 0.26 | 0.25 | 0.22 |
| Hardness, | 1.3 | 1.5 | 1.5 | 1.4 | 1.3 | 1.3 | 1.2 | 1.3 | 1.1 |
| <i>Metropolitan Water and Sewerage Board Examinations.</i> | | | | | | | | | |
| Color (platinum standard), | .33 | .35 | .32 | .28 | .25 | .27 | .22 | .23 | .18 |
| Turbidity, . | 2.3 | 2.2 | 2.4 | 1.9 | 2.2 | 2.2 | 2.4 | 2.6 | 2.1 |
| Total organisms, | 367 | 286 | 303 | 528 | 550 | 427 | 695 | 1,950 | 421 |
| Amorphous matter, | 34 | 36 | 36 | 37 | 42 | 47 | 64 | 97 | 72 |
| Bacteria, | 164 | 126 | 176 | 231 | 154 | 176 | 148 | 195 | 213 |

NOTE.—Chemical analyses are in parts per 100,000, organisms and amorphous matter in standard units per cubic centimeter, and bacteria in number per cubic centimeter. The standard unit has an area of 400 square microns, and by its use the number of diatomaceæ are decreased, and the number of chlorophyceæ and cyanophyceæ are very much increased, as compared with the number of organisms.

¹ Platinum standard.

In Appendix No. 2, tables 26 to 32, are given the results of chemical examinations made by the State Board of Health of the water supplied to the Metropolitan Water District.

SANITARY INSPECTION.

The inspection of the several watersheds on which the water supply is collected, and of the grounds connected with the several distributing reservoirs, for the purpose of preventing pollution of the supply or injury to the property of the Board, has been continued as in former years, with a force varying in number from 3 to 15 men. In connection with the inspection a sanitary census has been taken of the several watersheds, and the results as tabulated are presented in the following tables:—

Wachusett Watershed — Sanitary Census by Districts, 1910.

| DISTRICT. | PREMISES, | Number on which there are Dwellings throughout the year. | Summer cottagers. | Number of villages. | Number of Dwellings but no Other Buildings. | Number on which there are Stores or Other Buildings but no Dwellings. | Total Number. | Vaccin. | Number of dwellings. | Area (Square Miles, including Water Surfaces). | Permanent Population per Square Mile. | Permanent Population per Square Mile. | Sheep. | Cattle. | Horses. | Summer. | Permanently. | Swine. | Poultry. | Dogs. | Ducks. | |
|------------------------|-----------|--|-------------------|---------------------|---|---|---------------|---------|----------------------|--|---------------------------------------|---------------------------------------|--------|---------|---------|---------|--------------|--------|----------|-------|--------|--|
| | | | | | | | | | | | | | | | | | | | | | | |
| French Brook, | * | 49 | 4 | 4 | 1 | 58 | 730 | 206 | 26 | 28.2 | 42 | 219 | 4 | 13 | 1,220 | 18 | | | | | | |
| Muddy Brook, | * | 31 | 2 | 2 | 1 | 36 | 341 | 126 | 9 | 37.0 | 49 | 241 | - | 16 | 1,067 | 12 | | | | | | |
| Gates Brook, | * | 127 | 3 | 15 | 8 | 153 | 3,93 | 596 | 10 | 151.7 | 96 | 228 | 2 | 51 | 2,567 | 35 | | | | | | |
| McMadden Brook, | * | 22 | 3 | 1 | 1 | 27 | 3,05 | 121 | 11 | 39.7 | 32 | 138 | - | 7 | 1,042 | 12 | | | | | | |
| Chaffin Brook, | * | 162 | 1 | 6 | 12 | 181 | 10,56 | 733 | 5 | 69.4 | 111 | 306 | - | 140 | 5,914 | 59 | | | | | | |
| Aschumbuskit Brook, | * | 198 | 15 | 28 | 41 | 282 | 12,96 | 980 | 382 | 75.6 | 185 | 416 | 11 | 169 | 5,620 | 67 | | | | | | |
| Musochapauge, | * | 64 | 6 | 5 | 13 | 88 | 11,88 | 305 | 157 | 25.7 | 101 | 381 | - | 96 | 3,188 | 35 | | | | | | |
| South Wachusett Brook, | * | 61 | 12 | 8 | 4 | 85 | 11,33 | 228 | 72 | 20.1 | 96 | 434 | 25 | 35 | 1,862 | 23 | | | | | | |
| Trout Brook, | * | 28 | 1 | 2 | 2 | 33 | 7,65 | 116 | 3 | 15.2 | 28 | 85 | - | 13 | 1,248 | 11 | | | | | | |
| East Wachusett Brook, | * | 146 | 27 | 18 | 18 | 209 | 20,85 | 604 | 384 | 28.9 | 240 | 597 | 20 | 90 | 9,015 | 43 | | | | | | |
| Silhwater River, | * | 121 | 3 | 10 | 9 | 143 | 11,87 | 586 | 130 | 49.4 | 133 | 536 | 20 | 75 | 4,189 | 34 | | | | | | |
| Waushacum, | * | 130 | 218 | 20 | 8 | 376 | 7,70 | 571 | 815 | 74.2 | 131 | 429 | - | 87 | 2,779 | 35 | | | | | | |
| French Hill, | * | 28 | - | 1 | 1 | 30 | 5,67 | 110 | - | 19.4 | 20 | 51 | - | 1 | 412 | 9 | | | | | | |
| Totals, | * | 1,167 | 295 | 120 | 119 | 1,701 | 118,19 | 5,282 | 2,004 | 44.7 | 1,264 | 4,061 | 82 | 802 | 36,073 | 323 | | | | | | |

Sudbury and Cochituate Watersheds—Sanitary Census by Districts, 1910.

| DISTRICT. | PREMISES. | | POPULATION. | | WATER SUPPLY. | | Poultry. | | Dogs. |
|--|-----------|---------------------------------------|---------------|-----------------------|--------------------------------------|--|----------|--------|-------|
| | Total. | In Dwelling not connected with Sewer. | Total Number. | Connected with Sewer. | Premises having Public Water Supply. | Premises supplied by Private Wells, Cisterns, etc. | Cattle. | Sheep. | |
| <i>Sudbury Watershed.</i> | | | | | | | | | |
| Farm Pond, | 238 | 31 | 5 | 274 | 254 | 1,568 | 182 | 0.54 | 337.0 |
| Framingham Reservoir No. 3, | 82 | 2 | 3 | 87 | - | 363 | 363 | 5.35 | 67.9 |
| Stony Brook, | 250 | 21 | 24 | 295 | 1,522 | 1,302 | 1,302 | 13.29 | 98.0 |
| Angle Brook, | 1,808 | 116 | 52 | 1,976 | - | 2,255 | 9.16 | 246.2 | 1,814 |
| Framingham Reservoirs Nos. 1 and 2, and Cold Spring Brook, | 280 | 6 | 22 | 308 | - | 1,263 | 1,263 | 11.72 | 107.8 |
| Eastern Sudbury, | 190 | 18 | 12 | 220 | - | 884 | 884 | 3.11 | 284.2 |
| Indian Sudbury,* | 356 | 26 | 32 | 414 | - | 1,402 | 1,402 | 7.17 | 195.5 |
| Western Sudbury, | 160 | 16 | 8 | 184 | - | 641 | 641 | 7.85 | 81.7 |
| Whitelock Reservoir, | 90 | 8 | 15 | 113 | - | 321 | 321 | 4.22 | 40 |
| Cedar Swamp, | 702 | 47 | 98 | 510 | - | 3,351 | 1,143 | 9.40 | 121.6 |
| Totals, | 4,156 | 293 | 220 | 4,660 | 2,286 | 22,111 | 9,736 | 75.20 | 129.7 |
| <i>Cochituate Watershed.</i> | | | | | | | | | |
| Snake Brook, | 307 | 18 | 5 | 330 | 11 | 950 | 656 | 1,609 | 4.73 |
| Pegan Brook, | 877 | 71 | 11 | 877 | 4 | 610 | 4,455 | 1,404 | 2.24 |
| Course Brook, | 81 | 2 | 2 | 81 | 87 | 610 | 610 | 8.15 | 97.0 |
| Braver Dam Brook, | 1,076 | 77 | 28 | 1,181 | 866 | 7,844 | 1,514 | 1,514 | 1,014 |
| Totals, for both watersheds, | 2,341 | 168 | 48 | 2,557 | 1,524 | 14,518 | 4,877 | 18.73 | 260.4 |
| Totals, for both watersheds, | 6,497 | 461 | 268 | 7,226 | 3,810 | 36,629 | 14,633 | 93.93 | 155.8 |

* Includes Dudley Pond.

* Not including 98 summer cottages and camps on the shores of Lake Cochituate, with a population of 302 on August 1, 1910.

A comparison of these results with those of the Census of 1905 is shown by the following table:—

| | WACHUSSETT WATERSHED. | | SUDSBURY WATERSHED. | | COCHITUATE WATERSHED. | |
|--|--------------------------|-------|------------------------|--------|--------------------------|--------|
| | 1905. | 1910. | 1905. | 1910. | 1905. | 1910. |
| Premises occupied, | 1,658 | 1,582 | 4,607 | 4,449 | 2,873 | 2,509 |
| Premises vacant, | 102 | 119 | 303 | 220 | 74 | 48 |
| Premises connected with sewer, | — | — | 1,898 | 2,286 | 1,427 | 1,524 |
| Permanent population, | 5,772 | 5,282 | 21,131 | 22,111 | 15,508 | 14,518 |
| Permanent population per square mile in dwellings not connected with sewers, | 49 | 44.7 | 140.6 | 129.7 | 328.7 | 260.4 |
| Unsatisfactory cases, | 195 | 61 | 228 | 65 | 133 | 39 |

On the Wachusett watershed there has been a reduction of 9 per cent. in the population, and the number of unsatisfactory cases has been reduced from 195 to 61. Since 1905 several buildings on property purchased by the Board for the protection of the water supply, including the Dorr and Warfield mills and tenement houses connected therewith, have been torn down. All the large mills in Holden are now either idle or operating with a reduced number of employés. The decrease in population due to these conditions has been partially offset by the construction of 103 new houses, largely in the towns of West Boylston and Holden, which lie nearest Worcester, and to which better transportation facilities have recently been furnished.

On the Sudbury watershed there has been a reduction in the number of persons residing in houses not connected with sewers which discharge outside the watershed, and the unsatisfactory cases have been reduced from 228 to 65.

The drainage from the Dug Pond watershed, on which there was a resident population of 2,547, was diverted from the Cochituate watershed into Charles River in 1909 and although the remainder of the watershed gained 1,557 in population during the five years, there has been a decrease of 6 per cent. in the resident population on the Cochituate watershed, and the number of unsatisfactory premises has been reduced from 133 to 39.

Under the heading "unsatisfactory" are included all cases where it is possible that under the most unfavorable conditions drainage from privies or sinks may reach a water course, all suspected cases

and all cases of manufacturing wastes entering feeders, even though there may have been some attempt at previous purification.

On the Sudbury watershed 14 old and 18 new premises were, during the past year, connected with the public sewers which convey the drainage outside the watershed. Seven of these are in Marlborough, 10 in Westborough and 15 in Framingham. On the Cochituate watershed 13 old and 49 new premises were connected. Fifty of these are in Framingham and 12 in Natick. In the city and towns on the Sudbury and Cochituate watersheds which have systems of sewerage conveying the sewage outside the watershed, there were, on December 31, 1910, 3,810 premises connected with the sewers and 150 premises not yet connected on streets where there are existing sewers, as follows:—

| | Premises connected with Sewers. | Premises not connected with Sewers. |
|--|---------------------------------|-------------------------------------|
| Marlborough, | 1,522 | 83 |
| Westborough, | 510 | 25 |
| Framingham, | 1,116 | 9 |
| Natick, | 656 | 33 |
| Sherborn, | 6 | - |
| | 3,810 | 150 |

In Marlborough the regrading of some of the streets has changed the watershed line so that several houses which have been included in previous years are now outside the watershed. This has reduced the number of connections as given in the tables of former years.

Two watchmen were employed to patrol the grounds at Lake Cochituate, one from April 18 to October 1, with special reference to the protection of the supply during the bathing and camping season, and the other from July 16 to December 10, during the camping season and while the Italian laborers employed in constructing a drainage system were engaged in the vicinity of the lake.

The Boston & Worcester Street Railway Company employed a large gang of men for several months in grading the south side of the highway between Framingham Centre and the Southborough line. Measures were taken to prevent the pollution of the watershed on account of this work.

Two boys were summoned into court for bathing in Spot Pond on July 10. They were placed on probation.

On February 24 a resident of West Boylston was arrested for hunting on the marginal lands of the Wachusett Reservoir, and a fine of \$5 was imposed by the court.

The presence of a large number of visitors on the reservoir grounds at Chestnut Hill and Spot Pond during the summer season has made necessary the employment at times of men in patrolling the lands of the Board for the purpose of preventing the pollution of the supply and protecting the property. The extension of a car line from Boston through the Middlesex Fells to Stoneham has caused a very great increase in the number of people visiting the grounds around Spot Pond and the Fells Reservoir.

There were 3 cases of typhoid fever reported upon the Wachusett watershed, 1 of which was in Holden, 1 in Princeton and 1 in Boylston, and there were 2 cases of dysentery in Holden.

On the Sudbury and Cochituate watersheds there were 24 cases of typhoid fever reported from Marlborough, 4 from Westborough, 1 from Ashland, 83 from Wayland, 12 from Framingham and 6 from Natick, a total of 130 cases. Investigations made by our inspectors appear to indicate that the large number of cases which occurred in the village of Cochituate, in Wayland, during July, August and September were due to the use of milk from bottles which had not been properly sterilized.

The 24 cases in Marlborough were distributed throughout the year as follows:—

| | | | | | | | | | | | | |
|-----------|---|---|---|---|---|---|------------|---|---|---|---|----|
| January, | . | . | . | . | . | 1 | September, | . | . | . | . | 6 |
| February, | . | . | . | . | . | 2 | October, | . | . | . | . | 1 |
| March, | . | . | . | . | . | 1 | November, | . | . | . | . | 2 |
| May, | . | . | . | . | . | 2 | | | | | | |
| August, | . | . | . | . | . | 9 | | | | | | 24 |

The patients in 4 of the cases reported in September had been camping at Boone's Pond, in Hudson, and probably contracted the disease while there. Twenty-one of the premises from which cases were reported are connected with the public sewers. In all cases the premises were visited and precautions taken to prevent the spread of the disease or the pollution of the water supply.

A summary of the work of sanitary inspection for the year 1910 is given in the following tables:—

Summary of Sanitary Inspections on the Wachusett Watershed in 1910.

| DISTRICT. | Number of Premises inspected. | CLASSIFICATION OF CASES INSPECTED. | | WATER SUPPLY. | |
|------------------------|-------------------------------|------------------------------------|----------------|-------------------------------------|--|
| | | INDIRECT SINK DRAINS. | BARN DRAINAGE. | Premises having Publ. Water Supply. | Premises having Private Wells, Cis-terns, etc. |
| French Brook, | 58 | 26 | 1 | - | 27 |
| Muddy Brook, | 36 | 12 | 1 | - | 21 |
| Gates Brook, | 153 | 98 | 5 | 1 | 41 |
| Malden Brook, | 27 | 13 | 1 | - | 12 |
| Chaffin Brook, | 181 | 85 | 4 | - | 72 |
| Asnebunskit Brook, | 272 ¹ | 134 | 3 | 2 | 68 |
| Muschopauge, | 88 | 22 | - | 1 | 51 |
| South Wachusett Brook, | 85 | 32 | - | 1 | 43 |
| Trout Brook, | 33 | 4 | - | - | 25 |
| East Wachusett Brook, | 209 | 80 | - | 2 | 4 |
| Stillwater River, | 143 | 54 | - | - | 76 |
| Waushacum, | 166 ² | 62 | 3 | - | 1 |
| French Hill, | 30 | 19 | - | - | 9 |
| Totals, | 1,481 | 641 | 18 | 5 | 15 |
| | | | | 635 | 33 |
| | | | | 666 | 10 |
| | | | | 3 | 119 |
| | | | | 34 | 34 |
| | | | | 86 | 86 |
| | | | | 1,420 | 61 |
| | | | | 252 | 1,143 |
| | | | | | 86 |

¹ On some premises there are two or more easements.² Not including 10 summer cottages at Asnebunskit Pond.² Not including 210 summer cottages near Waushacum Lakes.

Summary of Sanitary Inspections on the Sudbury and Cochituate Watersheds in 1910.

| DISTRICT. | Number of Premises inspected. ¹ | CLASSIFICATION OF CASES INSPECTED. | | | | CONDITION AT END OF YEAR. |
|--|--|------------------------------------|-------------------|-------------------------|------------------|------------------------------|
| | | INDIRECT SINK DRAINAGE. | BARN DRAINAGE. | Unsanitary Drainage. | Premises Vacant. | |
| Sudbury Watershed. | | | | | | Unsanitary Drainage. |
| Farm Pond, | 274 | 9 | 2 | - | - | 5 |
| Framingham Reservoir No. 3, | - | 40 | 3 | - | - | 3 |
| Stony Brook, | - | 205 | 10 | - | - | 114 |
| Angle Brook, | - | 1,522 | 290 | 1 | 2 | 39 |
| Framingham Reservoir Nos. 1 and 2, and Cold Spring Brook, | 274 | - | 7 | - | - | 3 |
| Eastern Sudbury, | - | 308 | - | - | - | 227 |
| Indian Brook, | - | 414 | - | - | - | - |
| Western Sudbury; | - | 184 | - | - | - | - |
| Whitehall Reservoir, | - | 113 | - | - | - | - |
| Cedar Swamp, | - | 798 | 510 | 3 | - | - |
| Cochituate Watershed. | | | | | | Unsanitary Drainage. |
| Snake Brook, | - | 330 | 231 | 8 | - | 17 |
| Pegan Brook, | - | 959 | 656 | 225 | 1 | 43 |
| Course Brook, | - | 87 | 2 | 6 | 3 | 93 |
| Beaver Dam Brook, | - | 1,181 | 866 | 209 | 2 | 19 |
| Totals, | - | - | 3,810 | 2,077 | 71 | 88 |
| | | | 7,226 | | | 1,214 |
| | | | | | | 8 |
| | | | | | | 3 |
| | | | | | | 268 |
| | | | | | | 132 |
| | | | | | | 2,706 |
| | | | | | | 7,122 |
| | | | | | | 104 |

¹ On some premises there are two or more cases.

SWAMP DITCHES AND BROOKS.

The drainage ditches and swamps on the several watersheds, aggregating 36.36 miles in length, have been cleaned, and the weeds and brush mowed and burned for a width of from 10 to 20 feet on either side of the ditches. The work of replacing decayed wooden bulkheads on the settling basins at the outlets of ditches entering the open channel of the Wachusett Aqueduct was begun in 1909, and has been completed during the past year by the construction of eight concrete bulkheads 8 inches in thickness, fitted with stop-planks to control the elevation of the water. The cost of the work done during the past year was \$345.15. A dry rubble retaining wall on the west side of the highway leading from Marlborough to Westborough, at the crossing of the ditch leading from Brigham Pond, collapsed on March 18. It was rebuilt with stone laid in cement, at a cost of \$457.19, the work being finished on April 8. The slopes of the drainage ditches in swamps Nos. 54, 55 and 56, in Holden and Princeton, have been repaired for a distance of 1.46 miles, at a cost of \$104.03.

On the Sudbury watershed forty new farm bridges have been built over the drainage ditches, at points where the old bridges were decayed, and the ditches were repaired at several points by replacing the board bottom or repaving the slopes for an aggregate distance of 952 feet on the several ditches. The intercepting ditch along the east side of Pegan Meadow, at Lake Cochituate, was cleaned and the slopes mowed.

Observations of the colors of the waters from swamps have been made monthly and the results tabulated as follows:—

| SWAMP. | Area of Watershed (Acres). | Area of Swamp (Acres). | Length of Ditches (Feet). | COLORS OF WATERS (PLATINUM STANDARD). | | | | | |
|---------------|----------------------------|------------------------|---------------------------|--|--|------------------|-------|-------|-----|
| | | | | BEFORE DRAINING. | | AFTER DRAINING. | | | |
| | | | | Averages for Years 1894, 1895, 1899. | Averages for Years 1900, 1901, 1902. | 1907. | 1908. | 1909. | |
| | | | | | | | | 1910. | |
| Crane, . . . | 1,856 | 460 | 45,250 | 1.95 | — | .77 | .72 | .64 | .65 |
| No. 54, . . . | 750 | 72 | 8,930 | — | .90 | .53 | .41 | .33 | .36 |
| No. 55, . . . | 1,625 | 220 | 27,661 | — | 1.27 | .80 ¹ | .44 | .36 | .38 |
| No. 76, . . . | 225 | 26 | 6,173 | — | .44 | .27 | .24 | .20 | .21 |

¹ Nearly one-half of the ditches in Swamp No. 55 were not built until 1907.

PROTECTION OF SUPPLY.

In addition to the work of sanitary inspection and the care of the swamp ditches, the work of protecting the supply has included the maintenance and operation of filter-beds used to purify the surface water from thickly populated districts before it is admitted to the storage reservoirs. The Marlborough Brook filter-beds, with an area of 14 acres, filter the water from about 1.8 square miles of the thickly settled portion of the city of Marlborough before it is admitted to the Sudbury Reservoir. The settling basin in which the brook water is first received was cleaned in May and June. About 1,600 cubic yards of street washings and silt were removed and disposed of in grading the adjacent grounds, at a cost of about 28 cents per yard. The artificial filter-beds were cleaned twice during the year, once in June and again in September. The entire flow of the brook was filtered, with the exception of a small amount which overflowed from one of the beds into the reservoir on February 28 and March 1. Diluted sewage from the overflow of the Marlborough main sewer ran into the filter-bed on Farm Road on 5 days in January, 4 days in February, 11 days in March and 1 day in December, and there was a flow of ground water into the bed at times during the first four months and the last month of the year.

Surface drainage from an area of about one square mile in the thickly settled portion of Natick is collected in a basin and then pumped to filter-beds before entering Lake Cochituate. The pumps were operated on 155 days during the year, which is a less number than in any year since the beds were constructed. The total quantity pumped during the year was 210,806,000 gallons, equivalent to a daily average of 577,550 gallons. Of the total, 165,037,000 gallons were from Pegan Brook and 45,769,000 gallons from the intercepting ditch which collects water from brooks formerly draining into Pegan Brook Meadow. All of the water from Pegan Brook was filtered, but small quantities from the intercepting ditch were discharged into the lake on 5 days in January, 4 days in February and 5 days in March. The total quantity of coal consumed was 140,658 pounds, and 1,499 gallons of water were pumped per pound of coal. The cost of operating the station, cleaning the filter-beds and caring

for the grounds was \$2,691.58, making the cost per million gallons treated \$12.77.

The Sterling filter-beds have been in continuous operation throughout the year. All of the water coming from the brook which passes through the centre of the town of Sterling enters the filters, and has been efficiently cared for.

The Worcester County Training School filter-beds have been in operation continuously throughout the year, caring for all of the sewage of this institution.

The Gates Terrace filter-beds at Sterling Junction were in commission continuously from April 12 to November 12, inclusive.

FORESTRY.

In connection with the several reservoirs and aqueducts the Board has under its care and control about 10,000 acres of land a large part of which is covered with trees. Around the Wachusett Reservoir 1,341 acres of land have been planted with white pines during the past eight years. A considerable number of white pines have been planted around the Sudbury Reservoir. There are still several hundred acres on which it is proposed to plant pines, but the greater part of the forestal work now consists in the care of the trees which have been planted, the improvement thinning of forested areas and the care and improvement of forest roads. No additional area was planted on the Wachusett watershed during the past year with white pines as there was no suitable stock available, but the margin of the reservoir was replanted, for a distance of 13.6 miles, with arbor vitæ, spaced 3 feet apart in rows 2 feet apart. This work was necessary because a large proportion of the trees first planted had died. Thirty-six thousand one hundred trees were used in doing this work. Continuing work begun in 1909, 1,281 maples and 230 locusts have been transplanted from fields to the sides of 8.8 miles of highway in Clinton, Boylston, West Boylston and Sterling. Eighty-four white pine trees, averaging 6 feet in height, have been set out on a small grass plot opposite the Boston & Maine Station at Oakdale, also 7 white oaks. Eighteen sugar maples and 10 white oaks have been planted on the grounds at the Wachusett Dam. An area of 1.4 acres on Waushacum Street, in Oakdale, has been cleared and pre-

pared for use as a nursery for the propagation of trees, and it now contains about 30,000 white pine seedlings. The necessary care has been given to the Lamson and Flagg nurseries, and they now contain 18,200 two-year old white pine transplant seedlings and 42,800 arbor vitæ seedlings from 12 inches to 24 inches in height. The work of cutting out trees and brush which interfered with the growth of the young pines, and of making improvement thinning in timber stands varying from twenty to fifty years in age, has been continued.

Around the Wachusett Reservoir an improvement thinning on 112 acres of white pines was made at a cost of \$495.69, less \$114 received for 58 cords of wood; and 53 acres of old timber land was improved without any expense, as the value of the timber, cord wood, fence posts and railroad ties obtained was fully equal to the cost of making the improvement.

The brush and weeds on all forest roads, along all highway road-sides and on the 40-foot marginal fire guard at the Wachusett Reservoir have been cut and burned.

The lands about the Sudbury Reservoir have been improved by planting 2,500 arbor vitæ seedlings along the shore, on land formerly owned by S. A. and H. S. Howe on Parmenter Street, and on land formerly of W. A. Fay near the Framingham-Marlborough Road.

At Lake Cochituate 1,630 white pines have been planted on land made in 1909 by filling two shallow coves, and 50 white pines have been planted on the grounds at the effluent gate-house.

Three hundred pine trees were set out on the Sudbury Aqueduct land near Wellesley Avenue, in Wellesley, 100 alongside the Cochituate Aqueduct on land in Natick purchased of Harry Felch, and about 500 along the line of the Weston Aqueduct.

On the grounds about the Weston Reservoir 880 trees of different kinds have been set out, and at Spot Pond 100 trees and 2 shrubbery beds have been planted.

The work of protecting trees and shrubbery from the ravages of gypsy and brown-tail moths, pine-tree weevils, elm-leaf beetles and other destructive insects has caused the expenditure of \$6,010.21, distributed as follows:—

| | | | |
|---|-----------|---------|----|
| Spot Pond, | | \$2,645 | 35 |
| Mystic Lake, pumping station and reservoir, | | 144 | 85 |
| Chestnut Hill Reservoir, | | 648 | 89 |
| Weston Reservoir and Aqueduct, | | 1,246 | 75 |
| Sudbury and Cochituate aqueducts, | | 300 | 50 |
| Lake Cochituate, | | 109 | 25 |
| Sudbury Reservoir, | | 128 | 67 |
| Framingham Reservoir No. 3, | | 20 | 00 |
| Wachusett Reservoir and Aqueduct, gypsy and brown-tail moths, | | 185 | 31 |
| Wachusett Reservoir, pine-tree weevil, | | 580 | 64 |
| | | | |
| | | \$6,010 | 21 |

This sum is about \$2,000 less than the amount expended for the same purposes in 1909.

The method of destroying the insects has been the same as that followed in previous years. During the winter months the egg clusters of the gypsy moth were treated with a mixture of fuel oil and creosote, and the webs of the brown-tail moth were cut off and burned. Wherever the gypsy and brown-tail caterpillars or the elm-leaf beetles were present in large numbers during the summer the trees were sprayed with a mixture of arsenate of lead and water.

The large areas of young pine trees at the Wachusett Reservoir were inspected twice during the season, and all shoots found infested with the weevil were cut off and burned.

At Spot Pond the trees on about 14 acres of land were sprayed between May 26 and July 20, using 650 pounds of arsenate of lead, and 600 pounds of tanglefoot were used in banding the trees. At Chestnut Hill Reservoir 600 pounds of tanglefoot and 890 of arsenate of lead were used. At both Spot Pond and Chestnut Hill the elm-leaf beetle was very destructive, and constant watching and great thoroughness in spraying the trees were required to accomplish effective results. The elm trees were sprayed three times during the season.

At the Weston Reservoir 725 pounds of tanglefoot and 375 pounds of arsenate of lead were used, and about 14 acres of trees were sprayed. At this reservoir the cost of the work was largely increased by the fact that nothing whatever was done to suppress the moths by some of the adjacent property owners. The elm-leaf beetle was more prevalent than in previous years.

Along the Sudbury and Cochituate aqueduct lines the moths were found and destroyed in considerable numbers as far west as Wellesley and Natick.

At the Sudbury Reservoir 1,535 nests of the brown-tail moth and 65 egg clusters of the gypsy moth were destroyed, and a large number of pine tree shoots infested with the weevil were cut off and burned.

A few egg clusters of the gypsy moth have been found in the vicinity of the Wachusett Reservoir. The pine-tree weevil infested the young pines as in previous years but in smaller numbers. During July the whole area of 1,341 acres planted with young pines was inspected, and a second inspection was made in August. The proportion of trees infected varied from 1 in 3 on one or two small lots to 1 in 40 over a large proportion of the area.

In consequence of the extreme drought of the past year the number of forest fires has been unusually large, notwithstanding the fact that a fire-patrol service was maintained on Sundays and holidays at the Wachusett Reservoir and Spot Pond during the spring and fall. Twenty-four fires occurred on the property of the Board, causing a loss of about \$2,500. The more important of these were two at the Wachusett Reservoir, which destroyed about 16,000 young pine trees, two in Crane Swamp, which burned over about 90 acres of peat swamp covered with trees, and one near the Hopkinton Reservoir on the Sudbury watershed, which destroyed a good growth of chestnut and oak on about 30 acres.

DISTRIBUTING RESERVOIRS.

Weston Reservoir.

The reservoir, with its connected structures and grounds, has received the usual care and is in good order.

Chestnut Hill Reservoir.

The reservoir, gate-chambers and grounds are in good condition. The exterior woodwork of the old effluent gate-house has been given two coats of paint, and the iron floor of effluent gate-house No. 2 has been scraped and painted.

Waban Hill Reservoir.

The reservoir, gate-house and grounds are in good order.

Forbes Hill Reservoir and Standpipe.

The standpipe has been in use the entire year, and the reservoir has been kept full of water for use in case of emergency. The iron-work in the standpipe tower and the woodwork in the reservoir gate-chamber have been painted. The upper floor of the tower should be resurfaced.

Mystic Reservoir.

The roadway around the reservoir has been repaired, and the exterior woodwork and roof of the gate-house have been given two coats of paint. The reservoir has been in continuous use, except from November 10 to 21, when it was shut off on account of a drowning accident.

Mystic Lake and Pumping Station.

The Metropolitan Park Commission has been allowed to take about 1,500 cubic yards of gravel from a gravel pit on the west shore of the lake for use in resurfacing the Mystic Valley Parkway. A piece of land lying between old and new Mystic Streets, and containing 32,450 square feet, has been sold, as it had no value in connection with the water supply. The exterior woodwork of the old Mystic pumping station and the interior of the stable on the pumping station grounds have been painted.

Arlington Standpipe.

The standpipe has been in use the entire year. No repairs have been made during the year, but the standpipe should be repainted during the coming season.

Spot Pond.

The woodwork of the gate-houses has been painted and the interior iron-work given a coat of black varnish. For the convenience of the large number of visitors at the pond, and as an inducement to keep them away from the water, paths have been constructed on the property of the Board as follows: through what is known as the Deer Hill Lot, between Main Street and Dark Hollow Pond, for a distance of 2,850 feet; on the Hammer Neck Lot for a distance of 2,520 feet; and on the east shore of the pond from Woodland Road, passing by the rear of the pumping station, to the boat-house, a distance of about 1,500 feet. It is proposed to continue the construction of these paths

during the coming season. The question of the efficient protection of the water stored in this reservoir from pollution is becoming a serious one, on account of the large number of people who now use as a picnic ground the land draining into the pond, and it seems probable that a system of drains will soon be required to divert all surface water from the watershed from the pond.

PIPE YARDS.

The buildings at the Chestnut Hill and Glenwood pipe yards are in good condition, those at the Glenwood yard having received two coats of paint in the spring and those at the Chestnut Hill yard in the fall. The interior of the stable at Chestnut Hill was given a coat of hard oil finish.

PIPE LINES.

The length of pipe lines owned and operated by the Metropolitan Water and Sewerage Board was increased by 4.49 miles during the year, making a total on December 31, 1910, of 97.02 miles. The length of mains 4 inches in diameter and larger, connected with the works but owned and operated by the several cities and towns supplied with water, is 1,633.37 miles.

A number of changes in the Metropolitan pipe lines and in the connections between the Metropolitan mains and the pipes of the local distribution systems have been made during the year. The most important work done has been the relaying of 827 feet of 48-inch main on Boylston Street, in Cambridge, between the parkway at Charles River and Eliot Street. The relaying of this pipe, which had been in the ground but fourteen years, was made necessary by its having been injured by electrolysis, so as to be unsafe for further use. The pipes originally laid were 1.4 inches in thickness. The new pipes laid were 1.7 inches in thickness, and all of the joints, with the exception of those on a curve, were made of wood in place of lead, for the purpose of insulating the pipes and preventing injury in the future. This work was commenced on October 16 and completed on November 30, at a cost of \$12,221.40.

The construction of Crafts Road, crossing Reservoir Lane in Brookline, has made necessary the lowering of the 48-inch main in Reservoir Lane for a distance of about 275 feet and to a maximum

vertical distance of 6 feet. The main was lowered on November 8 without disconnecting the pipes, by the use of screws from which the main was suspended while the deeper trench was being excavated. In order to lower the pipes to the new grade it was necessary to cut into the top of the old Cochituate Aqueduct to a depth of about 1.6 feet. It is not probable that this portion of the aqueduct will ever be used, but to provide for possible use the brickwork was replaced. The cost of the portion of the work of lowering this main done by the Board was \$878.08, which is to be paid for by the town of Brookline.

The 20-inch main which is laid under the Mystic River at High Street, between Medford and Arlington, has been lowered so as to permit of the excavation of a deeper river channel by the Metropolitan Park Commission. The main was lowered for a length of 130 feet, at a cost of \$820.70. As the towns of Arlington and Lexington were entirely dependent upon this main for their water supply, a connection was made between the local distribution pipes in Arlington and Somerville by laying 591 feet of 8-inch pipe, of which 231 feet were furnished by the city of Somerville. By means of this connection a partial supply can be furnished in cases of emergency. The cost of making this connection was \$643.37.

The construction by the city of Boston of a large culvert at a new location, for use in carrying the waters of Stony Brook under Morton Street, near the Austin Farm, in West Roxbury, has made necessary the relocation of the Metropolitan 36-inch main. In order to avoid interference with the water-way through the culvert, the pipe line was reduced to 30 inches in diameter, and raised so that the top of the pipe is now within 2 feet of the surface of the street for a short distance directly over the culvert.

The construction of the subway in Cambridge by the Boston Elevated Railway Company has necessitated the relocation of 48-inch Metropolitan mains at Central and Harvard squares.

The changes at Central Square were described in the report for 1909, but the work was not completed until June 9 of the past year.

The construction of a subway station at Harvard Square has necessitated the relocation of the 48-inch main from a point 100 feet south of the corner of Boylston and Brattle streets to a point in Massachusetts Avenue 117 feet north of Church Street, a distance

of about 650 feet. The relocated pipe line is supported on the masonry structure of the subway for a distance of 400 feet, and at each of the points where the pipes leave the masonry support ball and socket joints were used as a safeguard in case of settlement of the pipes in the earth. At Brattle Street, on account of the shallow depth of cover over the subway roof, the 48-inch main was subdivided into three 24-inch mains, which are laid in special troughs constructed in the subway roof and covered with slabs of reinforced concrete, which protect the pipes from the heavy loads of street traffic. The 24-inch lines are each about 120 feet long, with a valve at either end. The concrete piers which support the 48-inch pipe over the subway are 9 feet long, 5 feet wide and from 6 inches to 2.7 feet high, depending upon the depth of the subway roof below the pipes. In order to maintain the flow of water while the subway construction was in progress a temporary 36-inch main was laid for a distance of 298 feet, and used from June 2 until October 16. The cost of all of these changes, both at Central and Harvard squares, was paid by the Boston Elevated Railway Company, and the employés of the Railway Company performed a large part of the work. The necessary pipes, special castings and valves were obtained under the supervision of this department, and all of the work not done by the department employés was very carefully inspected. The cost of the work done and materials furnished by the Board in connection with the changes at both Central and Harvard squares was \$16,693.75.

The two 24-inch mains crossing Chelsea Creek, used in supplying the East Boston District, have been covered with gravel, and the embankments riprapped where they were exposed at low water on the Chelsea shore.

A wooden insulation joint was substituted in December for a rubber joint in the 48-inch main on North Harvard Street, in Brighton, near the Charles River.

Forty-five leaks have been repaired on pipe lines maintained by the Board, at a cost of \$1,643.77. No serious breaks occurred in the mains during the year, but three cracked pipes were discovered, while pipe lines laid by contractors were being tested, before the mains had been placed in service. The cost of repairing these was \$165.77.

Nine leaks occurred at joints in the lines of 36-inch pipe crossing

under the Charles and Mystic rivers. In repairing these it was necessary to use a dredging machine and employ a diver. The cost of the repairs was \$955.27. The reduction in the leakage by repairing the submerged pipe lines was 270,000 gallons per day.

Twenty-six leaks were due to defective lead joints, of which four occurred under steam railroad tracks, and five were evidently caused by the settlement of the pipes, due to excavations made for other public work.

The steelwork of the bridge which supports the 48-inch main over the Fitchburg Division of the Boston & Maine Railroad at Massachusetts Avenue, in Cambridge, has been cleaned and painted with two coats of red lead and one coat of Smith's Durable Compound. The sheet lead with which the bottom of the bridge girder was covered in 1907, as a protection against the gases discharged from the locomotives, has been replaced with lead $\frac{5}{64}$ of an inch in thickness. A piece of asbestos mill board $\frac{1}{2}$ inch thick was also secured to the bottom of the girder over each track, as a protection for the sheet lead. A portion of the wooden roof covering the bridge was renewed with spruce lumber and the roof then covered with two-ply paroid roofing paper. The cost of this work was \$537.08.

The pipe bridge over the Mystic River in Medford has been thoroughly cleaned and painted; also three bridges carrying pipes over the Pines River in Saugus.

METERING OF WATER TO MUNICIPALITIES.

There were .62 Venturi meters, in sizes varying from 6 inches to, 60 inches, connected with the Metropolitan water mains on December 31, 1910, of which 49 were in use in measuring the water supplied to the several municipalities in the Metropolitan District. There were also 5 Hersey disc meters, 1 Hersey torrent, 1 Hersey detector, 1 Crown and 3 Union rotary meters, which were used to measure the water supplied in districts where the flow was too small to be conveniently measured with a Venturi meter. All of these meters have been read and inspected twice each week, and all necessary repairs made by a regular force of two men with an occasional assistant. Reports have been made monthly to the several municipalities supplied with water, giving the quantities used, and special re-

ports have been made from time to time of the increased use due to leakage or other causes.

Two cases in which the Venturi meters have detected large leaks which did not come to the surface of the ground and were not discovered by the local authorities are worthy of mention. In the city of Medford, in August, the meter indicated an increase of 1,000,000 gallons per day, which was, upon investigation, found to be due to a leak in a cement-lined pipe from which the water was escaping into the Mystic River. In another case a 3-inch main in Brighton was found to be broken, causing a leak, the water escaping into a sewer. The amount of leakage in this case was also about 1,000,000 gallons per day.

PRESSURE REGULATORS AND RECORDING GAGES.

There are eight automatic valves connected with the distribution system. Seven of these have been in constant use during the year to regulate the pressure in the mains in Nahant, Swampscott, Winthrop, Revere, Chelsea, East Boston high service and Lexington, and are in good condition.

The recording pressure gages connected with the distribution system have been in constant use and the average maximum and minimum elevations of the water, due to the pressure at nineteen points in different parts of the District, are given in Appendix No. 2, Table No. 42. The gage in Winthrop has been moved from the Water Works office to the Town Hall on Herman Street.

ELECTROLYSIS.

No complete electrical survey of the Metropolitan water mains was made during the past year, but special measurements have been made from time to time, and a careful examination was made of the pipes removed from Boylston Street, in Cambridge as described on page 118. The iron of these pipes, which was originally 1.4 inches in thickness, was found to be so badly decomposed that over considerable areas the material could be easily cut with a knife to a depth of from $\frac{1}{2}$ to $\frac{3}{4}$ of an inch. In seven lengths of pipe there were pittings one inch in depth. Along the bottom of one pipe there was a continuous pitting in the form of a groove about 3 inches wide, $\frac{5}{8}$ of an inch deep and $10\frac{1}{2}$ feet long, and in one pipe four holes were made entirely through the iron while cleaning out the pittings.

Joints of wood, in place of the ordinary lead joints, have been set on all new pipe lines laid during the year, at intervals of about 500 feet, for the purpose of preventing currents of electricity from following the mains.

CLINTON SEWERAGE.

Pumping Station.

The Clinton sewage-disposal works were in daily operation throughout the year. The quantity of sewage pumped to the filter-beds was 829,000 gallons per day, a decrease of 25,000 gallons per day from the preceding year.

Following are statistics relating to the operation of the pumping station:—

| | |
|--|------------|
| Daily average quantity of sewage pumped (gallons), | 829,000 |
| Daily average quantity of coal consumed (pounds), | 1,509 |
| Gallons pumped per pound of coal, | 549 |
| Number of days pumping, | 365 |
| Cost of pumping:— | |
| Labor, | \$1,946 04 |
| Fuel, | 1,217 32 |
| Repairs and supplies, | 382 56 |
| Total for station, | |
| Total for station, | \$3,545 92 |
| Cost per million gallons pumped, | \$11.721 |
| Cost per million gallons raised 1 foot high, | 0.239 |

There has been installed in the pump well a 2-inch hydraulic agitator for use in stirring up the sediment from the sewage, which collects around the foot valve of the pump. The pump plungers have been refitted, and a complete set of 72 new rubber valves placed in the pump. The woodwork of both the exterior and interior of the pumping station has been painted.

Filter-beds.

The filter-beds were used in rotation throughout the year, except as interrupted by the work of placing carriers on the beds and the building of sludge beds. Each bed has received an average of 61,100

gallons of sewage in thirty minutes about once in two days. All of the beds were used during the winter season.

The sludge collected in the settling basins, amounting to 688 cubic yards, has all been used on grass lands belonging to the Board at the pumping station and the Wachusett Dam and on the North Dike.

The results of the mechanical analyses of the sewage and effluent are given in the following table:—

[Parts per 100,000]

| | 1906. | 1907. | 1908. | 1909. | Average of Four Years, 1906-09. | 1910. | | Whole Year, 1910. |
|---------------------------------|--------|--------|--------|--------|------------------------------------|--------------------------|---------------------------|----------------------|
| | | | | | | Janu- ary to June. | July to De- cember. | |
| Albuminoid ammonia, sewage, | .8558 | .8442 | .5735 | .7425 | .754 | .6633 | .7487 | .7050 |
| Albuminoid ammonia, effluent, | .0955 | .0744 | .0554 | .0819 | .0768 | .0745 | .0628 | .0686 |
| Per cent. removed, | 89 | 91 | 90 | 89 | 89.7 | 89 | 92 | 90.3 |
| Oxygen consumed, sewage, | 9.84 | 7.87 | 3.43 | 7.04 | 7.045 | 6.10 | 7.2150 | 6.658 |
| Oxygen consumed, effluent, | 1.34 | 1.07 | 0.765 | 1.165 | 1.085 | 1.098 | 0.6742 | .8863 |
| Per cent. removed, | 86 | 87 | 78 | 83 | 83.5 | 82 | 91 | 86.7 |
| Free ammonia, sewage, | 3.5650 | 3.8342 | 4.6193 | 4.6283 | 4.1617 | 3.5700 | 4.203 | 3.8867 |
| Free ammonia, effluent, | 1.2723 | 1.3176 | 1.3722 | 1.2917 | 1.3134 | .9613 | .3373 | .6493 |
| Per cent. removed, | 64 | 66 | 70 | 70 | 67.5 | 73 | 92 | 83.3 |
| Nitrogen as nitrates, effluent, | .1445 | .1664 | .1468 | .2319 | .1724 | .3825 | 1.085 | .7338 |
| Iron, effluent, | 2.1042 | 2.2454 | 1.8100 | 1.7633 | 1.9807 | .9200 | .3590 | .6395 |

A comparison of the column showing the average results for the four years preceding 1910 with the results for the past year indicates that a very material improvement in the condition of the effluent has been accomplished through the construction of the under-drainage system and the placing of distributors on the surface of the beds during the past three years. The free ammonia in the effluent was less than one-half and the iron less than one-third of the average of the previous four years.

The cost of maintaining the filter-beds, exclusive of the cost of placing distributors on the beds and building two new sludge beds, has been as follows:—

| | | |
|---|-----------|------------|
| Labor, | | \$3,228 06 |
| Supplies and expenses, | | 125 36 |
| <hr/> | | |
| Total, | | \$3,353 42 |
| Cost per million gallons treated, | | 11 24 |

The increase in the cost of labor is due to the extra labor required to keep the surface of the beds clear of weeds, on account of the construction of the distributors.

There has been constructed a small shed for the storage of wagons, farming implements, tools, etc., at a cost of \$139.69.

Daily tests of the sewage and effluent, to determine the amount of dissolved oxygen and iron, have been made by the keeper in charge of the beds.

During the preceding two years extensive additions were made to the effective filtering area, the underdrainage system and surface distributors.

Continuing along the same line of improvements, in the past year there have been built carriers with concrete bottoms and plank sides upon 15 of the remaining 17 beds, thereby equipping 22 of the 24 one-acre beds. The total length of carriers constructed was 2,844 feet. Carriers have not been built on the 2 remaining beds, pending the removal of about 3 feet of undesirable filtering material at present on the top of these beds.

Two beds each 150 feet x 200 feet between centres of embankments, with a filtering prism of gravel and coarse sand 5 feet in depth, and an aggregate area of 1.06 acres, together with the necessary manholes, distributing pipes, gates and underdrains, have been constructed at the southeast corner of the filter-beds near the settling tanks. These beds are designed to have sufficient capacity to receive and care for the sludge from two settling basins at the same time, and are to be used for this purpose in place of two of the regular filter-beds which have been used for several years but which were not of sufficient area and not conveniently located.

Work was begun upon the construction of the concrete carriers on May 9, and they were completed on July 2, at a cost of \$2,808.42, or 99 cents per linear foot. Work on the construction of the sludge beds was begun on August 15, and they were completed on November

18, at a total cost of \$4,895.61. All of this work was done by day labor. The total amount expended in improving these beds during the past year has been \$7,704.03, and the total expended during the past three years, \$17,584.87.

ENGINEERING.

The greater portion of the time of the engineering force employed upon matters pertaining to the maintenance and operation of the works has been devoted to the superintendence of the operation of the Venturi meters and of the flow of water from the several reservoirs through the aqueducts; the determination of the quantities of water used in the several municipalities; the tabulation of the records of rainfall as measured at twelve stations on the works, of the elevations of the several storage and distributing reservoirs, and of the pressures in the mains at different points in the Metropolitan District; the making of calculations to determine the yield of the several watersheds, the quantities delivered by the several aqueducts, the quantities pumped at the several pumping stations and the cost of pumping, the testing of coal and oil, and the examination of the pipes to determine the injury from electrolytic action.

Special engineering work done during the year in connection with the maintenance of the works has included the giving of lines and grades and superintending the construction of filter-beds and distributing carriers at the Clinton sewerage filter-beds and of the new drainage system at Lake Cochituate. A survey of Framingham Reservoir No. 3 has been completed, and plans made on a scale of 100 feet to an inch showing the present high-water mark with reference to the lines of the property belonging to the Board; a survey of Framingham Reservoir No. 2, for the purpose of making similar plans, is now in progress; plans upon the same scale have also been completed, showing the existing shore and property lines around Lake Cochituate, and the location of the Sudbury and Cochituate aqueducts with the location of adjoining property lines and the names of present owners.

Appended to this report are tables giving the amount of work done and other information relative to contracts, a series of tables relating

to the maintenance of the Metropolitan Water Works, including the rainfall, yield of sources of supply, consumption of water in the different districts, the number of service pipes, meters and fire hydrants in the Metropolitan Water District, and a summary of statistics for 1910.

Respectfully submitted,

DEXTER BRACKETT,
Chief Engineer.

BOSTON, January 2, 1911.

REPORT OF CHIEF ENGINEER OF SEWERAGE WORKS.

To the Metropolitan Water and Sewerage Board.

GENTLEMEN:—The following is a report of the operations of the Engineering Department of the Metropolitan Sewerage Works for the year ending December 31, 1910.

ORGANIZATION.

The engineering organization during the year has been as follows:—

Division Engineers:

FREDERICK D. SMITH, . . *In charge of maintenance and construction,
South Metropolitan System.*

FRANK I. CAPEN, . . . *In charge of maintenance and construction,
North Metropolitan System.*

HENRY T. STIFF, . . . *In charge of office and drafting room.*

In addition to the above, there were employed at the end of the year 13 engineering and other assistants.

METROPOLITAN SEWERAGE DISTRICTS.

AREAS AND POPULATIONS.

During the year no changes have been made in the extent of the sewerage districts. The area of the North Metropolitan District remains at 90.50 square miles, and of the South Metropolitan District at 100.87 square miles,—a total, inclusive of water surfaces, of 191.37 square miles. These districts include the whole or parts of 25 cities and towns, as set forth in the following table.

The populations in the table are based on the census of 1910.

Table showing Areas and Estimated Populations within the Metropolitan Sewerage District, as of December 31, 1910.

| | CITY OR TOWN. | Area (Square Miles). | Estimated Population. |
|------------------------------|-----------------------------------|----------------------|-----------------------|
| North Metropolitan District. | Arlington, | 5.20 | 11,490 |
| | Belmont, | 4.66 | 5,720 |
| | Boston (portions of), | 3.45 | 103,007 |
| | Cambridge, | 6.11 | 105,920 |
| | Chelsea, | 2.24 | 33,090 |
| | Everett, | 3.34 | 34,310 |
| | Lexington, ¹ | 5.11 | 4,140 |
| | Malden, | 5.07 | 45,260 |
| | Melford, | 8.35 | 23,720 |
| | Melrose, | 3.73 | 15,930 |
| | Revere, | 5.86 | 18,870 |
| | Somerville, | 3.96 | 78,500 |
| | Stoneham, | 5.50 | 7,250 |
| | Wakefield, | 7.65 | 11,580 |
| | Winchester, | 5.95 | 9,480 |
| | Winthrop, | 1.61 | 10,480 |
| | Woburn, | 12.71 | 15,470 |
| | | 90.50 | 534,217 |
| South Metropolitan District. | Boston (portions of), | 20.39 | 183,000 |
| | Brookline, | 6.81 | 28,410 |
| | Dedham, ¹ | 9.40 | 9,350 |
| | Hyde Park, | 4.57 | 15,740 |
| | Milton, | 12.59 | 8,060 |
| | Newton, | 16.88 | 40,420 |
| | Quincy, | 12.56 | 33,320 |
| | Waltham, | 13.63 | 28,220 |
| | Watertown, | 4.04 | 13,150 |
| | | 100.87 | 359,670 |
| | Totals, | 191.37 | 893,887 |

¹ Part of town.

METROPOLITAN SEWERS.

SEWERS PURCHASED AND CONSTRUCTED AND THEIR CONNECTIONS.

During the year no additions by purchase or otherwise have been made within the sewerage districts, so that there are now 101.985 miles of Metropolitan sewers. Of this total, 8.79 miles of sewers, with the Quiney pumping station, have been purchased from cities and towns of the districts, the remaining 93.195 miles of Metropolitan sewers and other works having been constructed by the Metropolitan boards.

The locations, lengths and sizes of these sewers are given in the following tables, together with other data referring to the public and special connections with the system:—

North Metropolitan System.

¹ Includes .988 of a mile of sewer purchased from the city of Malden.

¹ Includes .738 of a mile of sewer purchased from the city of Melrose.

- Includes .756 of a mile of sewer purchased from the city of Melrose
- Includes 2.631 miles of sewer purchased from the town of Arlington

• The Metropolitan sewer extends but a few feet into the towns of Belmont and Wakefield.

⁴ Includes 2.787 miles of Mystic River valley sewer in Medford, Winchester and Woburn, running parallel with the Metropolitan sewer.

South Metropolitan System.

| CITY OR TOWN. | Size of Sewers. | Length in Miles. | Public Connections, December 31, 1910. | SPECIAL CONNECTIONS. | | Number in Operation. |
|------------------------|------------------------------|--------------------|--|--|-------|----------------------|
| | | | | Character or Location of Connection. | | |
| Boston (Back Bay), | 6' 6" to 3' 9", . . . | 1.500 ¹ | 13 | Tufts Medical School, . . . | . . . | 1 |
| | | | | Private house, . . . | . . . | 1 |
| Boston (Brighton), | 5' 9"×6' 0" to 12", . . | 6.010 ² | 12 | Administration Building, Boston Park Department, | . . . | 1 |
| Boston (Dorchester). | 3'×4' to 2' 6"×2' 7", . . | 2.870 ³ | 10 | Simmons College buildings, . | . . . | 1 |
| Boston (Roxbury), | 6' 6"×7', 4' 0", . . . | 1.430 | - | Art Museum, . . . | . . . | 2 |
| Boston (West Roxbury). | 9' 3"×10' 2" to 12", . . | 7.600 | 9 | Abattoir, . . . | . . . | 3 |
| Brookline, . . . | 6' 6"×7' 0" to 8", . . | 2.540 ⁴ | 12 | Chocolate works, . . . | . . . | 2 |
| Dedham, . . . | 4'×4' 1" to 3' 9"×3' 10", . | 2.350 | 5 | Machin shop, . . . | . . . | 1 |
| Hull, . . . | 60" pipe, . . . | 0.750 | - | Paper mill, . . . | . . . | 1 |
| Hyde Park, . . . | 10' 7"×11' 7" to 4'×4' 1", . | 4.527 | 17 | Private buildings, . . . | . . . | 2 |
| Milton, . . . | 11'×12' to 8", . . . | 3.600 | 18 | Mattapan Paper Mills, . . . | . . . | 1 |
| Newton, . . . | 4' 2"×4' 9" to 1' 3", . . | 2.911 | 6 | Private buildings, . . . | . . . | 2 |
| Quincy, . . . | 11' 3"×12' 6" to 24" pipe, . | 6.580 | 10 | Private houses, . . . | . . . | 2 |
| Waltham, . . . | 3' 6"×4", . . . | 0.001 | 1 | - | . . . | - |
| Watertown, . . . | 4' 2"×4' 9" to 12", . . | 0.750 ⁵ | 6 | - | . . . | - |
| | | | | Factories, . . . | . . . | 2 |
| | | | | Stanley Motor Carriage Co., . | . . . | 1 |
| | | 43.419 | 119 | | | 29 |

¹ Includes .355 of a mile of sewer purchased from the city of Boston.² Includes .446 of a mile of pipe and concrete sewers built for the use of the city of Boston; also, .026 of a mile of sewer purchased from the town of Watertown.³ Includes 1.24 miles of sewer purchased from the city of Boston.⁴ Includes .158 of a mile of pipe sewer built for the use of the town of Brookline.⁵ Includes .025 of a mile of sewer purchased from the town of Watertown.**COST OF CONSTRUCTION.**

[To December 31, 1910.]

The cost of the 101.985 miles of Metropolitan sewers enumerated above, including six pumping stations, screen-house, electric lift station, siphons and appertaining structures, may be summarized as follows: —

| | | |
|--------------------------------------|--------------|----|
| North Metropolitan System, | \$6,521,196 | 15 |
| South Metropolitan System, | 8,792,779 | 64 |
| | \$15,313,975 | 79 |

Information relating to areas, populations, local sewer connections and other data for the whole Metropolitan Sewerage District appear in the following table:—

North Metropolitan District.

| Area (Square Miles). | Estimated Total Population. | Miles of Local Sewer connected. | Estimated Population contributing Sewage. | Ratio of Contributing Population to Total Population (Per Cent.). | CONNECTIONS MADE WITH METRO- POLITAN SEWERS. | |
|----------------------------|-----------------------------------|---------------------------------------|--|--|--|----------|
| | | | | | Public. | Special. |
| 90.50 | 534,217 | 669.07 | 465,302 | 87.1 | 261 | 442 |

South Metropolitan District.

| | | | | | | |
|--------|---------|--------|---------|------|-----|----|
| 100.87 | 359,670 | 542.25 | 230,365 | 64.0 | 119 | 29 |
|--------|---------|--------|---------|------|-----|----|

Entire Metropolitan District.

| | | | | | | |
|--------|---------|----------|---------|------|-----|-----|
| 191.37 | 893,887 | 1,211.32 | 695,667 | 77.8 | 380 | 471 |
|--------|---------|----------|---------|------|-----|-----|

Of the estimated gross population of 893,887 on December 31, 1910, 695,667 representing 77.8 per cent., were on that date contributing sewage to the Metropolitan sewers, through a total length of 1,211.32 miles of local sewers owned by the individual municipalities. These sewers are connected with the Metropolitan System by 380 public and 471 special connections. It appears, also, that there has been during the year an increase of 34.75 miles of local sewers connected with the Metropolitan System, and that 21 public and 8 special connections have been added.

PUMPING STATIONS AND PUMPAGE.

The following table shows the average daily volume of sewage lifted at each of the six Metropolitan pumping stations during the year, as compared with the corresponding volumes for the previous year:—

| PUMPING STATION. | AVERAGE DAILY PUMPAGE. | | |
|--|------------------------------------|------------------------------------|------------------------------------|
| | Jan. 1, 1909, to Dec. 31, 1909. | Jan. 1, 1910, to Dec. 31, 1910. | Increase during the Year. |
| Deer Island, | Gallons. 60,600,000 | Gallons. 59,000,000 | Gallons. 1,600,000 ¹ |
| East Boston, | 58,600,000 | 57,000,000 | 1,600,000 ¹ |
| Charlestown, | 32,100,000 | 34,300,000 | 2,200,000 |
| Alewife Brook, | 3,358,000 | 3,585,000 | 227,000 |
| Quincy, | 4,163,000 | 4,132,000 | 31,000 ¹ |
| Ward Street (actual gallons pumped), . . . | 22,700,000 | 22,900,000 | 200,000 |

¹ Decrease.

CONSTRUCTION.

NORTH METROPOLITAN SYSTEM.

DEER ISLAND PUMPING STATION.

The construction provided for in chapter 566 of the Legislative Acts of 1908 for extensions and additions to the Deer Island pumping station has been practically completed during the year. The additions to the pumping plant, including the 100,000,000-gallon pump, four boilers, economizer and piping, are fully installed, and have been operated in the continuous working service of the house since early in April.

During the year, by-pass channels on the main sewer under the screen-house have been completed by day labor. Contracts for new screening machinery for both the by-pass channel and the main sewer were made with the Hyde Windlass Company of Bath, Me., May 16, 1910. This new screening machinery has been placed by the engineers of the Department; on the by-pass channel, the new screens have been in operation since early in October. On the main sewer, the screens and machinery will be ready for operation early in February.

During the year, two new electric generators, furnished by B. F. Sturtevant Company of Hyde Park, of 17½ kilowatt capacity each, have been placed in the new engine room; new wiring and new electrical fixings and fixtures have been introduced in the new and old engine rooms, the boiler room, coal house and screen rooms. A machine shop has been fitted up at the end of the coal house with small

power engine, lathe, power drills, grinders, work benches, forge and blacksmith's outfit. This work has been placed by the engineers of the Department.

During the year, day-labor forces under the direction of the engineer have placed a masonry floor in the new engine house and a new tiled floor in the new and old engine rooms and screen room. Wooden bulkheads and posts in the old coal house have been replaced during the year by reinforced concrete posts and bulkheads.

Test of Deer Island Engine.

Tests of the 100,000,000-gallon engine at Deer Island, as specified in the contract with the Allis-Chalmers Company, were made November 30 and December 1, 1910. These tests were made under the immediate direction of Frank I. Capen, Division Engineer, and William M. Francis, Mechanical Engineer, for the Metropolitan Sewerage Works, and J. R. Belknap, Mechanical Engineer for the Allis-Chalmers Company.

This engine, pump, piping and four new boilers and appurtenances were furnished by the Allis-Chalmers Company of Milwaukee, Wis., under a contract dated November 3, 1908.

The pump was erected between October, 1909, and February, 1910, and was first operated in February, 1910. By agreement between the Board and the Allis-Chalmers Company it has been operated on the regular service of the station since April, 1910, prior to the official test and acceptance by the Board.

The following tables contain principal dimensions of engine and boilers:—

Principal Dimensions of Engine and Pump.

| | |
|---|-----------|
| Diameter H. P. cylinder (inches), | 18 |
| Diameter I. P. cylinder (inches), | 32 |
| Diameter L. P. cylinder (inches), | 46 |
| Stroke of pistons (inches), | 30 |
| Diameter of suction (inches), | 60 |
| Diameter of discharge (inches), | 60 |
| Revolutions per minute, | 80 to 104 |

Principal Dimensions of Boilers.

| | |
|--|-----------------|
| Steam pressure (pounds), | 125 |
| Diameter of shell inside smallest ring (inches), | 98 |
| Thickness of plates (inches), | $1\frac{3}{16}$ |
| Diameter of furnace inside (inches), | 48 |
| Length of furnace (feet), | 13 |
| Length of tubes (feet), | 13 |
| Diameter of tubes (inches), | $2\frac{1}{2}$ |
| Number of tubes, | 130 |
| Length of grate (feet), | 6 |
| Width of grate (feet), | 4 |

Contract Requirements.

The contract provides that the engine shall fulfil the following requirements:—

Capacity, 100,000,000 United States gallons per twenty-four hours with lift of 19 feet.

The actual head against which the pump is acting to be measured every fifteen minutes by a mercury or other approved gage at a point near the pump end of the discharge channel. This credits the pump with all friction through the Venturi meter, check valves and discharge channels.

Duty guaranteed, 96,500,000 foot-pounds of work for each 1,000 pounds of commercially dry steam used by the engine and auxiliary pump supplied by the Contractor. Steam containing less than $1\frac{1}{2}$ per cent. of entrained water, as determined by calorimeter measurements, to be considered as commercially dry steam.

The pump to discharge into the varying elevations of the tide.

The duration of the test to be twelve hours, starting at low tide, with a minimum lift of 9 feet, and gradually rising to 19 feet at high tide.

The actual elevations in the suction channel to be measured every fifteen minutes by a gage in the suction manhole. The average of all the varying lifts to be used in determining the duty of the pump.

The quantity of sewage lifted to be determined from meter readings taken once every fifteen minutes during the trial by a manometer on the Venturi meter. The sewage to be screened, and to consist of about two-thirds ordinary domestic sewage and about one-

third sea water, introduced into the sewer at convenient points above the station.

The engine to be operated continuously during the twelve hours of the trial, under the conditions before outlined, and supplied with steam of not more than 125 pounds pressure per square inch by gage at the throttle valve.

The trials of the engine to be conducted jointly by the Engineer and a representative of the Contractor.

If the duty determined by the official trials of the engine were found to be less than that guaranteed by the Contractor, the sum of \$500 for each 1,000,000 foot-pounds of work unperformed below the guaranteed duty, and pro rata for fractional parts, would be deducted from the price bid by the Contractor. If the duty shown by the official trials of the engine were 10 per cent. less than that guaranteed in the contract, the Board might reject the engine.

The type and design of the boilers were specified in the contract, so that no formal boiler tests were required.

Trial.

To furnish the 100,000,000 gallons of water required during the test, tide water was allowed to enter the sewer through the tide gates at Malden River. This tide water furnished about one-third of the total quantity required. To regulate the quantity to be pumped to the rate of 100,000,000 gallons per twenty-four hours, the check valve of the No. 1 pump at the station was braced open. No. 1 pump and engine were also braced so that they could not move. By operating the penstock valve on the suction of this pump, water was allowed to flow back from the discharge sewer in sufficient quantity to give the 100,000,000 gallons per twenty-four hours required during the test. The water in the suction sewer was held at approximately elevation 98, and the elevation in the discharge sewer varied with the tide.

Three boilers furnished the steam used during the test. Steam was conveyed to the engine through one of the duplicate lines of 8-inch steam main, and in order that the leakage should be reduced to the minimum, all connections between this duplicate main and auxiliary steam lines were blanked off by plates inserted between flanges of pipes.

The feed water was taken directly from the city main, weighed in

barrels on platform scales and fed to the boilers by the feed pump connected with the engine. For this service a temporary 3-inch pipe line was extended to the economizer.

Quarter-hour observations were made of all pressure gages and other apparatus used in connection with the test. The elevation of water in the discharge channel was determined by a mercury gage, and the quantities of sewage pumped were determined by a manometer attached to the Venturi meter. The height of the water in the suction channel was determined by a hook gage. Calorimeter measurements of the moisture in the steam were made hourly during the test.

All observations were made both by representatives of the Metropolitan Water and Sewerage Board and the Allis-Chalmers Company.

Trial Data and Results.

| | |
|------------------------------|----------------------------------|
| Date of trial, | November 30 and December 1, 1910 |
| Duration of trial, | 12 hours |

Average Pressures.

| | |
|--|--------|
| Steam at boilers (pounds), | 127.70 |
| Steam at throttle (pounds), | 126.50 |
| First receiver (pounds), | 20.10 |
| Second receiver (inches of mercury), | 5.83 |
| Vacuum, | 25.20 |

Head Pumped against.

| | |
|--|--------|
| Average elevation in suction channel, | 98.20 |
| Average net head pumped against, | 14.74 |
| Average elevation in discharge channel corrected for losses in discharge pipe, Venturi meter, and check valve, | 112.94 |
| Minimum head pumped against, | 10.88 |
| Maximum head pumped against, | 18.20 |

Revolutions.

| | |
|---|-----------|
| Total revolutions during test, | 68,797.00 |
| Average revolutions per minute, | 95.55 |

Useful Work performed by Engine.

| | |
|---|-------------|
| Total water pumped (United States gallons per twenty-four hours), | 100,700,000 |
|---|-------------|

Water fed to Boilers.

| | |
|--|--------|
| Total water weighed (pounds), | 55,987 |
| Deduct leakage from boilers, pipes, valves and waste from calorimeter, | 906 |
| Total steam chargeable to engine, | 55,081 |
| Average entrainment of moisture in steam entering engine in excess of 1½ per cent. (0.19 per cent.), | 105 |
| Total dry steam used by engine (pounds), | 54,976 |

Duty.

| | |
|---|-------------|
| Duty on foot-pounds per 1,000 pounds commercially dry steam corrected for losses, | 112,800,000 |
| Duty foot-pounds per 1,000 pounds water fed to boilers, | 110,753,300 |

Horse Power and Efficiency.

| | |
|---|--------|
| Average indicated horse power, | 391.92 |
| Average water horse power, | 260.96 |
| Efficiency per cent., | 66.60 |
| Water per indicated horse power per hour, | 11.69 |

The duty developed by this engine during its tests of 112,800,000 foot-pounds of work for each 1,000 pounds of commercially dry steam used exceeds the duty of 96,500,000 foot-pounds guaranteed by the engine builders in their contract by 16.9 per cent.

The efficiency of the pump and engine developed in the test, and expressed in a ratio of useful work accomplished to indicated steam horse power developed, was 66.6 per cent. This exceeds by 20 per cent. the efficiency developed by other engines in this station.

The new plant, including engine, pump, boiler and appurtenances, operated satisfactorily during the tests, and has continued to give satisfactory results since that date in the regular service of the station.

Except for minor repairs, during the year of probation specified in the contract, the plant is in condition for formal acceptance.

EAST BOSTON PUMPING STATION.

Chapters 556 and 582 of the Acts of 1908 provided for repairs to the East Boston station, burned in April, 1908, and for new engine, boiler and coal houses and wharf, with an additional engine, boilers, piping and connections.

As outlined in the last report contracts for repairs to the old station and construction for the new buildings were made in 1909. The building contracts were fully completed as early as November 1, 1910. On July 15, 1910, a contract was made with the John T. Scully Foundation and Transportation Company for pile wharf, steel floor and coal runs. The work under this contract was completed on November 30, 1910.

The wharf is about 40 feet wide at the northerly end of the coal house and extends along the rear of the house for its entire length, varying in width from 10 to 20 feet. This contract included the placing of two coal runs with steel framing. The wharf is built with spruce piles and spurshores and oak fender piles. These are framed with a capping of steel channel irons and diagonal braces of angle irons. It is intended that the wharf construction shall be fire-proof. To accomplish this, the steel frames and piles are to be surrounded with concrete and the wharf deck to be of reinforced concrete. This concrete work will be done by day labor under the direction of the Engineer. A portion of the wharf deck at the end of the coal house has been placed and some of the piles surrounded by concrete. This work will be completed in the spring. A concrete retaining wall at the easterly end of the coal house, to defend the approach to the wharf, has been placed during the year by day labor.

As stated in last year's report, a contract was made with the Allis-Chalmers Company of Milwaukee for one 100,000,000-gallon centrifugal pump and engine. The parts for this engine arrived about December 1, and are now being erected. The engine may be in condition to operate some time during the month of March.

The foundations for this pump and engine have been constructed by day labor, under the direction of the Engineer, together with the floor of the basement of the new engine room, of concrete reinforced with twisted steel. The main floor of the new engine room was also placed by day labor. It is of framed steel beams surrounded by concrete and covered with a floor of reinforced concrete. The suction channel leading from the pump well to the new engine has been enlarged for a length of 28 feet, and is now equivalent in area to a pipe 60 inches in diameter. This work has been done by day labor.

The boilers mentioned in the last report as contracted for with the

Robb-Mumford Company have arrived, and have been placed on foundations in the new boiler room, and at the date of this report are equipped and connected and will be in condition to use about the first of March.

Two economizers of 144 3-inch tubes each have been furnished and erected in the boiler room by the B. F. Sturtevant Company. The necessary piping and connections between the engine and boilers are to be made at a later date by the Board.

STABLE AND LOCKER BUILDING.

A concrete sea wall has been constructed along the rear of the locker building lot at the corner of Addison and Chelsea streets. The foundations for a stable and locker building 28 feet x 65 feet, two stories high, have been built. The building itself is about half completed.

The foundations and building are of reinforced concrete, including floors and roof. The windows and doors are of steel and the roof will be covered with a terra cotta promenade tile. It is believed that the building will be fire-proof. The work is being done by day labor under the direction of the Engineer.

SOUTH METROPOLITAN SYSTEM.

SEWAGE LIFT AT HOUGH'S NECK, QUINCY.

Chapter 424 of the Acts of 1899, the High-level Sewer Act, provides that the Board shall construct such pumping stations as shall enable the city of Quincy to drain its sewerage systems by gravity into the Metropolitan sewers.

The mayor of Quincy notified the Board of the intention of the city to construct sewers in low areas at Hough's Neck in the vicinity of Island Avenue, the drainage from which will require to be lifted to the High-level Sewer.

Chapter 292 of the Acts of 1910 authorized the Board to expend such sums as may be required, from unexpended balances of appropriations, to construct necessary works to enable the city of Quincy to drain, by gravity, its territory into the High-level Sewer.

The territory for which relief has been requested includes the easterly and southerly ends of Hough's Neck, involving an ultimate area of 170 acres. This district will ultimately be served by about 8 miles of local sewers. At present, about 3 miles of local sewers

are to be built, and it may be many years before more territory will need drainage. The drainage from the area to be sewered at once will be very small. The point at which it will naturally be collected is at the Commonwealth's lot on the westerly side of Island Avenue. This lot is about half a mile distant from the Nut Island screen-house. Provision has been made for lifting this small amount of sewage by an automatic electrically-actuated lift, maintained and operated by the engineers at the Nut Island screen-house. The power for this service is furnished by generators at the Nut Island screen-house.

The works include a concrete storage and pump well holding 50,000 gallons; electrical conduits connecting with the Nut Island screen-house two 6-inch centrifugal pumps of 1,500,000 gallons capacity, each per day actuated by electrical motors; a sewage lift building 14 feet square, covering the pump well, of brick with Quincy granite trimmings and red slate roof.

Contracts for carrying out the work have been made as follows:—

John Cashman & Sons Company, receiving basin, foundations and appurtenances, dated August 29, 1910.

B. F. Sturtevant Company, motors and pumping machinery, dated October 21, 1910.

C. A. Dodge Company, station building, dated November 14, 1910.

At the date of this report the Cashman contract is completed, with the exception of some grading and placing of loam. The building is constructed, the pumps are installed and the plant will be ready to operate in the early spring.

MAINTENANCE.

SCOPE OF WORK AND FORCE EMPLOYED.

The maintenance of the Metropolitan Sewerage System includes the operation of 7 stations and 101.985 miles of Metropolitan sewers, receiving the discharge from 1,211.32 miles of town and city sewers at 380 points, together with the care and study of inverted siphons under streams and in the harbor.

The permanent maintenance force of 148 men includes 88 engineers and other employés at the pumping stations, and 60 men employed on actual sewer maintenance and care of pumping station grounds. In the following two tables the use of the completed systems and other data are shown:—

NORTH METROPOLITAN SYSTEM.

Table showing Cities and Towns delivering Sewage in this System; Approximate Miles of Sewer connected; Estimated Populations and Areas now contributing; Total Areas ultimately to contribute, and Present Populations on Such Areas; Ratios of Present Contributing Areas to Ultimate Areas, and Ratios of Populations now contributing to Present Total Populations.

[Populations estimated as of December 31, 1910.]

| CITIES AND TOWNS. | Miles of Local Sewer connected. | Separate, Separate or Combined. | Number of Connections with Local Sewers. | Estimated Number of Persons served by Each House Connection. ¹ | Estimated Population now contributing Sewage. | Estimated Present Total Population. | Estimated Area now contributing Sewage. | Area ultimately to contribute Sewage. | Ratio of Contributing Population to Present Total Population. | Per Cent. |
|-------------------------|---------------------------------|---------------------------------|--|---|---|-------------------------------------|---|---------------------------------------|---|-----------|
| Boston (Deer Island), | 0.70 | Separate, | - | - | 1,347 ² | 1,347 ² | Sq. Miles. | Sq. Miles. | Per Cent. | Per Cent. |
| Winthrop, | 29.92 | Separate, | 2,393 | 4.30 | 10,290 | 10,480 | - | 1.29 | 1.61 | 100.0 |
| Boston (East Boston), | 30.43 | Separate and combined, | 4,568 | 12.50 | 57,100 | 59,840 | - | 2.18 | 2.18 | 98.2 |
| Chelsea, | 29.21 ³ | Separate and combined, | 3,332 ⁴ | 9.00 | 29,990 | 33,090 | 1.08 | 1.08 | 95.4 | 95.4 |
| Everett, | 43.80 | Separate and combined, | 4,289 | 6.55 | 28,095 | 34,310 | 1.10 | 2.24 | 2.24 | 90.6 |
| Everett, | 55.64 | Separate, | 5,441 | 6.10 | 33,190 | 34,310 | 1.89 | 3.34 | 3.34 | 81.9 |
| Melrose, | 35.91 | Separate, | 2,735 | 4.60 | 12,810 | 15,930 | 2.81 | 2.81 | 5.07 | 55.4 |
| Boston (Charlestown), | 21.16 | Separate and combined, | 5,272 | 7.90 | 41,650 | 41,820 | 1.75 | 1.75 | 3.73 | 46.9 |
| Cambridge, | 144.03 | Separate and combined, | 15,299 | 6.85 | 104,795 | 105,920 | 0.67 | 1.27 | 99.6 | 62.8 |
| Somerville, | 94.59 | Separate and combined, | 14,217 | 5.45 | 77,480 | 78,500 | 4.99 | 4.99 | 6.11 | 81.7 |
| Medford, | 52.92 | Separate, | 3,970 | 5.75 | 22,825 | 23,720 | 3.33 | 3.33 | 3.96 | 98.7 |
| Winchester, | 24.05 | Separate, | 1,236 | 5.40 | 6,675 | 9,480 | 2.83 | 2.83 | 8.35 | 96.2 |
| Woburn, | 13.95 ⁵ | Separate, | 1,065 | 5.70 | 6,070 | 15,470 | 1.17 | 1.17 | 50.4 | 19.7 |
| Stoneham, | 11.75 | Separate, | 744 | 5.70 | 3,495 | 12,710 | 0.95 | 0.95 | 32.71 | 7.5 |
| Arlington, | 23.64 | Separate, | 1,968 | 6.10 | 7,735 | 11,490 | 0.63 | 0.63 | 48.2 | 11.5 |
| Belmont, | 13.40 | Separate, | 1,668 | 6.50 | 4,195 ⁶ | 5,720 | 1.72 | 5.20 | 67.3 | 33.1 |
| Wakefield, | 11.75 | Separate, | 660 | 5.70 | 3,190 | 11,580 | 1.05 | 4.66 | 73.3 | 29.5 |
| Lexington, ⁷ | 32.22 | Separate, | 2,436 | 5.90 | 14,370 | 4,140 | 0.46 | 7.65 | 27.5 | 6.0 |
| Revere, | 669.07 | - | 69,443 | 6.70 | 465,302 | 534,217 | 1.77 | 5.86 | 76.2 | 30.2 |
| Totals, | | | | | | | 90.50 | 87.1 | | 32.6 |

¹ Estimated from assessors' statement of the number of houses in each city or town, on April 1, 1910, and the population from census of 1910.

² Estimated by Superintendent James H. Cronin of the Institution on Deer Island.

³ The districts connecting at Cypress Street, Revere Beach Parkway, Springdale Avenue, Willoughby, Bellingham, Highland, Hawthorn and Spruce streets are now contributing sewage.

⁴ Estimated.

⁵ Exclusive of Mystic River valley sewer and tanneries.

⁶ Including 2 connections with McLean Hospital, having an estimated population of 503.

⁷ Lexington not connected.

SOUTH METROPOLITAN SYSTEM.

Table showing Cities and Towns delivering Sewage to this System; Approximate Miles of Sewer connected; Estimated Populations and Areas now contributing; Total Areas ultimately to contribute, and Present Populations on Such Areas; Ratios of Present Contributing Areas to Ultimate Areas, and Ratios of Populations now contributing to Present Total Populations.

[Populations estimated as of December 31, 1910.]

| CITIES AND TOWNS. | Miles of Local Sewer connected. | Separate or Combined. | Number of Connections with Local Sewers. | Estimated Number of Persons served by Each House Connection. ¹ | Estimated Population now contributing Sewage. | Estimated Present Total Population. | Estimated Area now contributing Sewage. | Area ultimately to contribute Sewage. | Ratio of Contributing Population to Present Total Population. | Sq. Miles. | Per Cent. |
|------------------------|---------------------------------|------------------------|--|---|---|-------------------------------------|---|---------------------------------------|---|------------|-----------|
| Boston (Back Bay), | 24.65 | Separate and combined, | 1,608 | 17.00 | 27,335 | 27,800 | 1.24 | 1.61 | .983 | .770 | |
| Boston (Brighton), | 55.78 | Separate and combined, | 2,994 | 6.20 | 18,560 | 27,300 | 3.17 | 3.74 | .680 | .848 | |
| Brookline, | 65.33 | Separate and combined, | 3,625 | 7.50 | 27,190 | 26,410 | 3.43 | 6.81 | .657 | .564 | |
| Newton, | 110.04 | Separate, | 5,850 | 5.90 | 34,515 | 40,420 | 7.10 | 16.88 | .854 | .421 | |
| Watertown, | 35.14 | Separate, | 1,828 | 5.50 | 10,065 | 13,150 | 1.93 | 4.04 | .765 | | |
| Waltham, | 43.14 | Separate, | 3,439 | 7.65 | 26,210 | 28,220 | 2.22 | 13.63 | .929 | .163 | |
| Boston (Dorchester), | 49.12 | Separate and combined, | 4,719 | 7.50 | 35,390 | 59,300 | 2.32 | 4.89 | .597 | .474 | |
| Milton, | 9.83 | Separate and combined, | 459 | 5.80 | 2,525 | 8,060 | 0.63 | 12.59 | .731 | .50 | |
| Hyde Park, | 26.24 | Separate, | 1,513 | 7.60 ² | 11,500 | 15,740 | 1.28 | 4.57 | .731 | .280 | |
| Dedham, | 14.54 | Separate, | 525 | 5.40 | 2,835 | 9,350 ³ | 0.73 | 9.40 | .303 | .78 | |
| Boston (Roxbury), | - | Separate and combined, | - | - | - | 40,000 | - | 1.23 | - | - | |
| Boston (West Roxbury), | 47.83 | Separate and combined, | 2,751 | 5.80 | 16,955 ⁴ | 28,600 | 2.29 | 8.92 | .593 | .257 | |
| Quincy, | 60.61 | Separate, | 3,263 | 5.30 | 17,295 | 33,320 | 2.80 | 12.56 | .519 | .223 | |
| Totals, | 542.25 | - | - | 32,574 | 7.10 | 230,365 ⁴ | 355,670 | 29.14 | 100.87 | 64.0 | 28.9 |

¹ Estimated from assessors' statement of the number of houses in each city or town, on April 1, 1910, and the population from census of 1910.

² Estimated by City Engineer.

³ Including connection with Institution at Austin Farm, having an estimated population of 1,000.

⁴ Part of town not included in Metropolitan Sewerage District.

* Corrected from former estimates by census of 1910.

CAPACITY AND RESULTS.

The following tables summarize the pumping records for the year for the Metropolitan sewerage stations:—

NORTH METROPOLITAN SYSTEM.*Deer Island Pumping Station.*

At this station are four submerged centrifugal pumps with impellers or wheels 8.25 feet in diameter, driven by triple-expansion engines of the Reynolds-Corliss type.

Contract capacity of 1 pump: 100,000,000 gallons, with 19-foot lift.

Contract capacity of 3 pumps: 45,000,000 gallons each, with 19-foot lift.

Average duty for the year: 42,300,000 foot-pounds.

Average quantity raised each day: 59,000,000 gallons.

Force employed: 4 engineers, 4 firemen, 3 oilers, 3 screenmen and 1 relief screenman.

Coal used: Georges Creek, Pocahontas and New River, costing from \$3.815 to \$4.13 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the Deer Island Pumping Station of the North Metropolitan System.

| MONTHS. | Total Pumpage (Gallons). | Average per Day (Gallons). | Minimum Day (Gallons). | Maximum Day (Gallons). | Average Lift (Feet). | Average Duty (ft.-lbs. per 100 lbs. Coal). |
|--------------------|--------------------------------|----------------------------------|------------------------------|------------------------------|----------------------------|---|
| 1910. | | | | | | |
| January, | 2,662,200,000 | 85,900,000 | 58,100,000 | 134,700,000 | 11.92 | 45,200,000 |
| February, | 2,394,900,000 | 85,500,000 | 54,700,000 | 117,200,000 | 12.70 | 45,700,000 |
| March, | 2,298,600,000 | 74,100,000 | 49,600,000 | 135,100,000 | 11.12 | 41,000,000 |
| April, | 1,677,200,000 | 55,900,000 | 46,500,000 | 72,900,000 | 11.24 | 40,700,000 |
| May, | 1,605,700,000 | 51,800,000 | 43,300,000 | 65,000,000 | 10.83 | 39,000,000 |
| June, | 1,909,800,000 | 63,700,000 | 43,800,000 | 109,600,000 | 11.77 | 54,300,000 |
| July, | 1,525,000,000 | 49,200,000 | 36,600,000 | 64,500,000 | 10.09 | 41,300,000 |
| August, | 1,437,800,000 | 46,400,000 | 38,800,000 | 59,700,000 | 10.09 | 36,100,000 |
| September, | 1,382,900,000 | 46,100,000 | 36,000,000 | 62,200,000 | 10.03 | 41,200,000 |
| October, | 1,460,400,000 | 47,100,000 | 39,100,000 | 52,100,000 | 9.97 | 42,000,000 |
| November, | 1,519,000,000 | 50,600,000 | 34,300,000 | 103,800,000 | 10.90 | 42,100,000 |
| December, | 1,596,000,000 | 51,500,000 | 36,000,000 | 107,400,000 | 10.16 | 38,500,000 |
| Total, | 21,460,500,000 | - | - | - | - | - |
| Average, | - | 59,000,000 | 43,100,000 | 90,400,000 | 10.90 | 42,300,000 |

East Boston Pumping Station.

At this station are three submerged centrifugal pumps, with impellers or wheels 8.25 feet in diameter, driven by triple-expansion engines of the Reynolds-Corliss type.

Contract capacity of pumps: 45,000,000 gallons each, with 19-foot lift.

Average duty for the year: 45,500,000 foot-pounds.

Average quantity raised each day: 57,000,000 gallons.

Force employed: 4 engineers, 4 firemen, 3 oilers, 3 screenmen, 1 relief screenman and 3 helpers.

Coal used: New River, costing from \$3.545 to \$4.20 per gross ton.

ARTHUR D. BUZZBY, C.E.
Table of Approximate Quantities, Lifts and Duties at the East Boston Pumping Station of the North Metropolitan System.

| MONTHS. | Total Pumpage (Gallons). | Average per Day (Gallons). | Minimum Day (Gallons). | Maximum Day (Gallons). | Average Lift (Feet). | Average Duty (ft.-lbs. per 100 lbs. Coal). |
|----------------------|--------------------------|----------------------------|------------------------|------------------------|----------------------|--|
| 1910. | | | | | | |
| January, | 2,600,200,000 | 83,900,000 | 56,100,000 | 132,700,000 | 15.75 | 50,200,000 |
| February, | 2,338,900,000 | 83,500,000 | 52,700,000 | 115,200,000 | 15.45 | 45,600,000 |
| March, | 2,236,600,000 | 72,100,000 | 47,600,000 | 133,100,000 | 15.59 | 49,000,000 |
| April, | 1,617,200,000 | 53,900,000 | 44,500,000 | 70,900,000 | 15.23 | 47,700,000 |
| May, | 1,543,700,000 | 49,800,000 | 41,300,000 | 63,000,000 | 15.36 | 47,800,000 |
| June, | 1,849,800,000 | 61,700,000 | 41,800,000 | 107,600,000 | 15.36 | 43,000,000 |
| July, | 1,463,000,000 | 47,200,000 | 34,600,000 | 62,500,000 | 14.78 | 35,900,000 |
| August, | 1,375,800,000 | 44,400,000 | 36,800,000 | 57,700,000 | 14.98 | 46,300,000 |
| September, | 1,322,900,000 | 44,100,000 | 34,000,000 | 60,200,000 | 15.08 | 45,800,000 |
| October, | 1,398,400,000 | 45,100,000 | 37,100,000 | 50,100,000 | 15.15 | 45,500,000 |
| November, | 1,459,000,000 | 48,600,000 | 32,300,000 | 101,800,000 | 14.70 | 48,100,000 |
| December, | 1,534,000,000 | 49,500,000 | 34,000,000 | 105,400,000 | 15.16 | 41,400,000 |
| Total, | 20,739,500,000 | - | - | - | - | - |
| Average, | - | 57,000,000 | 41,100,000 | 88,400,000 | 15.22 | 45,500,000 |

Charlestown Pumping Station.

At this station are three submerged centrifugal pumps, two of them having impellers or wheels 7.5 feet in diameter, the other 8.25 feet in diameter. They are driven by triple-expansion engines of the Reynolds-Corliss type.

Contract capacity of pumps: two, 22,000,000 gallons each, with 11-foot lift; one, 60,000,000 gallons, with 8-foot lift.

Average duty for the year: 55,500,000 foot-pounds.

Average quantity raised each day: 34,300,000 gallons.

Force employed: 4 engineers, 4 firemen, 3 oilers, 3 screenmen and 1 relief screenman.

Coal used: New River, costing from \$3.835 to \$3.90 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the Charlestown Pumping Station of the North Metropolitan System.

| MONTHS. | Total Pumpage (Gallons). | Average per Day (Gallons). | Minimum Day (Gallons). | Maximum Day (Gallons). | Average Lift (Feet). | Average Duty (ft.-lbs. per 100 lbs. Coal). |
|----------------------|--------------------------|----------------------------|------------------------|------------------------|----------------------|--|
| 1910. | | | | | | |
| January, | 1,383,600,000 | 44,600,000 | 32,300,000 | 69,300,000 | 8.60 | 60,900,000 |
| February, | 1,276,000,000 | 45,600,000 | 36,000,000 | 63,200,000 | 9.99 | 56,200,000 |
| March, | 1,167,600,000 | 37,700,000 | 26,100,000 | 69,400,000 | 10.79 | 55,100,000 |
| April, | 1,041,000,000 | 34,700,000 | 27,200,000 | 47,600,000 | 10.63 | 57,800,000 |
| May, | 978,200,000 | 31,600,000 | 25,200,000 | 41,700,000 | 9.49 | 62,300,000 |
| June, | 1,130,600,000 | 37,700,000 | 29,000,000 | 53,200,000 | 8.49 | 55,700,000 |
| July, | 963,100,000 | 31,100,000 | 25,100,000 | 39,500,000 | 8.25 | 53,700,000 |
| August, | 858,700,000 | 27,700,000 | 22,900,000 | 35,800,000 | 8.16 | 50,100,000 |
| September, | 879,100,000 | 29,300,000 | 23,800,000 | 39,100,000 | 8.20 | 53,500,000 |
| October, | 853,900,000 | 27,500,000 | 22,400,000 | 31,500,000 | 8.12 | 53,100,000 |
| November, | 929,900,000 | 31,000,000 | 22,400,000 | 56,100,000 | 8.30 | 53,500,000 |
| December, | 1,008,600,000 | 32,500,000 | 23,200,000 | 55,000,000 | 8.34 | 54,300,000 |
| Total, | 12,470,300,000 | - | - | - | - | - |
| Average, | - | 34,300,000 | 26,300,000 | 50,100,000 | 8.95 | 55,500,000 |

Alewife Brook Pumping Station.

The plant at this station consists of the original installation of small commercial pumps and engines, *i.e.*, two 9-inch Andrews vertical centrifugal pumps, with direct-connected compound marine engines, together with the recent additions. The latter consists of a specially designed engine of the vertical cross-compound type, having between the cylinders a centrifugal pump rotating on a horizontal axis.

Contract capacity of the two original pumps: 4,500,000 gallons each, with 13-foot lift.

Contract capacity of new pump: 13,000,000 gallons, with 13-foot lift.

Average duty for the year: 18,600,000 foot-pounds.

Average quantity raised each day: 3,585,000 gallons.

Force employed: 3 engineers, 1 relief engineer, 2 screenmen, and 1 relief screenman.

Coal used: New River, Pocahontas and Elk Garden, costing from \$4.23 to \$4.73 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the Alewife Brook Pumping Station of the North Metropolitan System.

| MONTHS. | Total Pumpage (Gallons). | Average per Day (Gallons). | Minimum Day (Gallons). | Maximum Day (Gallons). | Average Lift (Feet). | Average Duty (ft.-lbs. per 100 lbs. Coal). |
|--------------------|--------------------------|----------------------------|------------------------|------------------------|----------------------|--|
| 1910. | | | | | | |
| January, | 198,550,000 | 6,437,000 | 4,201,000 | 9,453,000 | 12.68 | 27,000,000 |
| February, | 200,420,000 | 7,158,000 | 5,300,000 | 8,701,000 | 12.84 | 29,200,000 |
| March, | 196,397,000 | 6,335,000 | 3,380,000 | 9,055,000 | 12.81 | 26,100,000 |
| April, | 108,037,000 | 3,601,000 | 2,928,000 | 5,170,000 | 12.70 | 18,600,000 |
| May, | 92,462,000 | 2,963,000 | 2,246,000 | 4,260,000 | 12.79 | 16,900,000 |
| June, | 100,849,000 | 3,362,000 | 2,162,000 | 5,753,000 | 12.75 | 18,300,000 |
| July, | 74,214,000 | 2,394,000 | 2,036,000 | 3,079,000 | 12.89 | 15,600,000 |
| August, | 61,511,000 | 1,984,000 | 1,742,000 | 2,786,000 | 12.89 | 14,400,000 |
| September, | 62,496,000 | 2,083,000 | 1,700,000 | 3,380,000 | 12.88 | 14,200,000 |
| October, | 60,063,000 | 1,938,000 | 1,580,000 | 2,550,000 | 12.92 | 13,700,000 |
| November, | 70,079,000 | 2,336,000 | 1,952,000 | 4,877,000 | 12.94 | 14,300,000 |
| December, | 75,343,000 | 2,430,000 | 1,868,000 | 5,300,000 | 12.96 | 14,300,000 |
| Total, | 1,300,421,000 | - | - | - | - | - |
| Average, | - | 3,585,000 | 2,591,000 | 5,347,000 | 12.84 | 18,600,000 |

SOUTH METROPOLITAN SYSTEM.

Ward Street Pumping Station.

At this station are two vertical, triple-expansion pumping engines, of the Allis-Chalmers type, operating reciprocating pumps, the plungers of which are 48 inches in diameter with a 60-inch stroke.

Contract capacity of pumps: 50,000,000 gallons each, with 45-foot lift.

Average duty for the year: 82,500,000 foot-pounds.

Average quantity raised each day: 22,900,000 gallons.

Force employed: 4 engineers, 4 firemen, 4 oilers, 4 assistant engineers, 1 machinist and 1 laborer.

Coal used: New River, costing from \$4.095 to \$4.30 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the Ward Street Pumping Station of the South Metropolitan System.

| MONTHS. | Total Pumpage (Gallons). | Average per Day (Gallons). | Minimum Day (Gallons). | Maximum Day (Gallons). | Average Lift (Feet). | Average Duty (ft.-lbs. per 100 lbs. Coal). |
|--------------------|-----------------------------|----------------------------------|------------------------------|------------------------------|----------------------------|---|
| 1910. | | | | | | |
| January, | 982,800,000 | 31,700,000 | 18,700,000 | 60,900,000 | 40.73 | 98,400,000 |
| February, | 887,200,000 | 31,700,000 | 24,300,000 | 44,400,000 | 41.11 | 101,000,000 |
| March, | 959,000,000 | 30,900,000 | 24,100,000 | 45,200,000 | 41.23 | 97,000,000 |
| April, | 697,900,000 | 23,300,000 | 20,100,000 | 28,000,000 | 40.21 | 81,300,000 |
| May, | 659,500,000 | 21,300,000 | 17,500,000 | 27,100,000 | 40.11 | 82,700,000 |
| June, | 727,000,000 | 24,200,000 | 17,500,000 | 37,100,000 | 39.94 | 85,000,000 |
| July, | 621,100,000 | 20,000,000 | 16,000,000 | 28,500,000 | 39.73 | 82,600,000 |
| August, | 534,500,000 | 17,200,000 | 14,200,000 | 21,300,000 | 39.28 | 74,500,000 |
| September, | 532,100,000 | 17,700,000 | 15,200,000 | 23,300,000 | 39.49 | 75,000,000 |
| October, | 569,900,000 | 18,400,000 | 15,200,000 | 20,300,000 | 39.42 | 69,200,000 |
| November, | 596,900,000 | 19,900,000 | 16,000,000 | 39,200,000 | 39.50 | 73,400,000 |
| December, | 591,600,000 | 19,100,000 | 16,300,000 | 33,600,000 | 39.52 | 69,500,000 |
| Total, | 8,359,500,000 | - | - | - | - | - |
| Average, | - | 22,900,000 | 17,900,000 | 34,100,000 | 40.02 | 82,500,000 |

Records from plunger displacement.

Average slip for the year about 10.4 per cent.

Quincy Pumping Station.

At this station are two compound condensing Deane pumping engines and one Lawrence centrifugal pump driven by a Sturtevant compound condensing engine.

Contract capacity of pumps: 3,000,000 Deane; 5,000,000 Deane; 10,000,000 Lawrence centrifugal.

Average duty for the year: 33,967,000 foot-pounds.

Average quantity raised each day: 4,132,000 gallons.

Force employed: 3 engineers, 1 relief engineer, 2 screenmen and 1 relief screenman.

Coal used: Cumberland, costing from \$3.93 to \$4.50 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the Quincy Pumping Station of the South Metropolitan System.

| MONTHS. | Total Pumpage (Gallons). | Average per Day (Gallons). | Minimum Day (Gallons). | Maximum Day (Gallons). | Average Lift (Feet). | Average Duty (ft.-lbs. per 100 lbs. Coal). |
|--------------------|-----------------------------|-------------------------------|---------------------------|---------------------------|-------------------------|--|
| 1910. | | | | | | |
| January, | 169,784,000 | 5,477,000 | 3,980,000 | 7,720,000 | 23.16 | 33,100,000 |
| February, | 160,154,000 | 5,720,000 | 4,980,000 | 6,665,000 | 23.12 | 35,500,000 |
| March, | 185,923,000 | 5,998,000 | 5,015,000 | 7,290,000 | 23.35 | 37,200,000 |
| April, | 147,770,000 | 4,926,000 | 4,450,000 | 5,175,000 | 21.24 | 40,100,000 |
| May, | 139,120,000 | 4,488,000 | 4,010,000 | 5,230,000 | 21.27 | 40,100,000 |
| June, | 119,680,000 | 3,989,000 | 3,620,000 | 4,620,000 | 21.29 | 36,700,000 |
| July, | 105,690,000 | 3,409,000 | 3,025,000 | 3,635,000 | 21.26 | 33,600,000 |
| August, | 96,505,000 | 3,113,000 | 2,740,000 | 3,460,000 | 21.21 | 31,700,000 |
| September, | 88,485,000 | 2,950,000 | 2,740,000 | 3,235,000 | 21.22 | 29,600,000 |
| October, | 89,505,000 | 2,887,000 | 2,660,000 | 3,420,000 | 21.18 | 29,800,000 |
| November, | 97,015,000 | 3,234,000 | 2,830,000 | 3,630,000 | 21.13 | 31,200,000 |
| December, | 105,325,000 | 3,398,000 | 3,025,000 | 3,940,000 | 21.20 | 29,000,000 |
| Total, | 1,504,956,000 | - | - | - | - | - |
| Average, | - | 4,132,000 | 3,590,000 | 4,835,000 | 21.72 | 33,967,000 |

Nut Island Screen House.

The plant at this house includes two sets of screens in duplicate, actuated by small reversing engines of the Fitchburg type. Two vertical Deane boilers, 80 horse-power each, operate the engines, provide heat for the house and burn materials intercepted at the screens.

Average quantity of sewage passing screens daily, 39,600,000 gallons.

Total materials intercepted at screens during the past year, 1,043.3 cubic yards.

Materials intercepted per million gallons of sewage discharged, 1.95 cubic feet.

Force employed: 3 engineers, 1 relief engineer, 3 screenmen and 1 relief screenman.

Coal used: New River and Cumberland, costing from \$3.98 to \$4.05 per gross ton.

COST OF PUMPING.

In the following tables the total cost of pumping and the rate per million foot-gallons at each of six pumping stations are shown in detail:—

Average Cost per Million Foot-gallons for Pumping at the Deer Island Station.

Volume (21,469.5 Million Gallons) \times Lift (10.90 Feet) = 234,017.6 Million Foot-gallons.

| ITEMS. | Cost. | Cost per Million Foot-gallons. |
|--------------------------------------|-------------|--------------------------------------|
| Labor, | \$12,612 60 | .05390 |
| Coal, | 10,383 31 | .04437 |
| Oil, | 384 19 | .00164 |
| Waste, | 190 95 | .00082 |
| Water, | 1,360 80 | .00581 |
| Packing, | 303 25 | .00130 |
| Miscellaneous supplies and renewals, | 2,047 94 | .00875 |
| Totals, | \$27,283 04 | \$0.11659 ¹ |
| Labor at screens, | - | .01222 |

¹ The increased cost of pumping over the record for the preceding year is due to the unusual conditions of operation, occasioned by the installation during the year of a new pumping engine and new sewage screens, necessitating modification of channels and plant; the labor thereon requiring the use of extra materials, increased consumption of coal for hoisting materials and almost continuous operation of the lighting plant, and other incidental expenses of which the amounts cannot be readily estimated.

Average Cost per Million Foot-gallons for Pumping at the East Boston Station.

Volume (20,739.5 Million Gallons) \times Lift (15.22 Feet) = 315,655.2 Million Foot-gallons.

| ITEMS. | Cost. | Cost per Million Foot-gallons. |
|--------------------------------------|-------------|--------------------------------------|
| Labor, | \$15,596 57 | .04941 |
| Coal, | 11,198 22 | .03547 |
| Oil, | 320 51 | .00102 |
| Waste, | 102 39 | .00032 |
| Water, | 1,644 00 | .00521 |
| Packing, | 50 24 | .00016 |
| Miscellaneous supplies and renewals, | 1,067 59 | .00338 |
| Totals, | \$29,979 52 | \$0.09497 |
| Labor at screens, | - | .00898 |

*Average Cost per Million Foot-gallons for Pumping at the Charlestown Station.*Volume (12,470.3 Million Gallons) \times Lift (8.95 Feet) = 111,609.2 Million Foot-gallons.

| ITEMS. | Cost. | Cost per Million Foot-gallons. |
|--------------------------------------|--------------------|--------------------------------------|
| Labor, | \$11,413 18 | \$0.10226 |
| Coal, | 3,910 61 | .03504 |
| Oil, . | 199 35 | .00179 |
| Waste, | 98 70 | .00088 |
| Water, | 453 60 | .00406 |
| Packing, . | 40 40 | .00036 |
| Miscellaneous supplies and renewals, | 642 41 | .00576 |
| Totals, | \$16,758 25 | \$0.15015 |
| Labor at screens, | - | .02538 |

*Average Cost per Million Foot-gallons for Pumping at the Alewife Brook Station.*Volume (1,300.4 Million Gallons) \times Lift (12.84 Feet) = 16,697.1 Million Foot-gallons.

| ITEMS. | Cost. | Cost per Million Foot-gallons. |
|--|-------------------|--------------------------------------|
| Labor, | \$5,695 86 | \$0.34113 |
| Coal, | 1,569 76 | .09401 |
| Oil, . | 149 08 | .00893 |
| Waste, | 76 50 | .00458 |
| Water, | 254 20 | .01523 |
| Packing, . | 60 63 | .00363 |
| Miscellaneous supplies and renewals, | 556 85 | .03335 |
| Totals, | \$8,362 88 | \$0.50086 |
| Labor at screens, oiling and miscellaneous services, | - | .11214 |

*Average Cost per Million Foot-gallons for Pumping at the Ward Street Station.*Volume (8,359.5 Million Gallons) \times Lift (40.02 Feet) = 334,547 Million Foot-gallons.

| ITEMS. | Cost. | Cost per Million Foot-gallons. |
|--------------------------------------|--------------------|--------------------------------------|
| Labor, | \$14,136 76 | \$0.04226 |
| Coal, | 7,575 98 | .02264 |
| Oil, . | 304 28 | .00091 |
| Waste, | 36 08 | .00010 |
| Water, | 1,390 80 | .00416 |
| Packing, . | 126 68 | .00038 |
| Miscellaneous supplies and renewals, | 1,645 76 | .00492 |
| Totals, | \$25,216 34 | \$0.07537 |
| Labor at screens, | - | .01306 |

*Average Cost per Million Foot-gallons for Pumping at the Quincy Station.*Volume (1,505.0 Million Gallons) \times Lift (21.72 Feet) = 32,689 Million Foot-gallons.

| ITEMS. | Cost. | Cost per Million Foot-gallons. |
|--|------------|--------------------------------------|
| Labor, | \$4,733 18 | \$0.14480 |
| Coal, | 1,511 02 | .04622 |
| Oil, | 35 59 | .00109 |
| Waste, | 15 18 | .00048 |
| Water, | 225 02 | .00688 |
| Packing, | 33 11 | .00101 |
| Miscellaneous supplies and renewals, | 573 21 | .01754 |
| Totals, | \$7,126 93 | \$0.21802 |
| Labor at screens, oiling and miscellaneous services, | - | .04772 |

Coal for use at the several stations has been purchased as follows:—

| | GROSS TONS, BITUMINOUS COAL. | | | | | | Contract Price per Gross Ton. ¹ |
|--|------------------------------|------------------------------|------------------------------|--------------------------------|------------------------------|-------------------------|--|
| | Deer Island Pumping Station. | East Boston Pumping Station. | Charlestown Pumping Station. | Alewife Brook Pumping Station. | Ward Street Pumping Station. | Quincy Pumping Station. | |
| Staples Coal Company, | - | - | 672.3 | - | - | - | - |
| New England Coal and Coke Company. | - | 1,603.79 | - | - | - | - | 3 69 |
| Staples Coal Company, | 899.8 | - | - | - | - | - | 3 74 |
| New England Coal and Coke Company. | - | - | 318.0 | - | - | - | 3 90 |
| Eastern Coal Company, | - | 300.00 | - | - | - | - | 4 00 |
| Staples Coal Company, | 639.5 | - | - | - | - | - | 4 04 |
| Staples Coal Company, | - | - | - | - | 1,421.32 | - | 4 09 |
| New England Coal and Coke Company. | - | 780.11 | - | - | - | - | 4 10 |
| Neponset River Coal Company, | - | - | - | - | - | 328.85 | - |
| Eastern Coal Company, | - | 191.56 | - | - | - | - | 4 20 |
| Metropolitan Coal Company, | 1,519.0 | - | - | - | - | - | 4 20 |
| New England Coal and Coke Company. | - | - | - | 225.41 | - | - | 4 25 |
| Staples Coal Company, | - | - | - | - | 399.33 | - | 4 29 |
| Metropolitan Coal Company, | - | - | - | - | 130.66 | - | 4 30 |
| Frost Coal Company, | - | - | - | - | - | 66.65 | - |
| New England Coal and Coke Company. | - | - | - | 179.74 | - | - | 4 55 |
| Staples Coal Company, | - | - | - | - | 74.00 | - | 4 55 |
| Total gross tons, | 3,058.3 | 2,875.46 | 990.3 | 405.15 | 2,025.31 | 395.50 | 390 |
| Average price per gross ton, | \$4 03 | \$3 87 | \$3 72 | \$4 38 | \$4 16 | \$4 21 | \$3 98 |

¹ These prices are given without adjustments for quality.

NORTH METROPOLITAN SYSTEM.**SIPHON UNDER ALEWIFE BROOK.**

The pipe siphons under Alewife Brook, fully described in the last annual report, were finished and put in operation on January 26, 1910. Occasional flushing is found necessary to maintain these siphons.

PIPE UNDER CAMBRIDGE SUBWAY.

The siphon on the Cambridge branch of the Metropolitan sewer, under the subway at Portland Street, fully described in the last report, was completed by the Elevated Railway Company on January 11, 1910.

Since that date this siphon has been successfully operated by the maintenance force. It has required flushing and cleaning as often as twice a week.

CHANGES IN LOCATION OF METROPOLITAN SEWER AT CAMBRIDGE SUBWAY, ELIOT SQUARE, CAMBRIDGE.

Under authority of chapter 520, Acts of 1906, the Boston Elevated Railway Company, with the approval of the Board, relocated during the year a length of Metropolitan sewer between stations 33 + 55 and 38 + 25 of section 30 of the Cambridge branch of the North Metropolitan System.

This length is located in Eliot Street and Eliot Square. The Metropolitan sewer in that vicinity is 2 feet 10 inches wide and 3 feet high, of a modified horseshoe section. The relocation is west of the original sewer, in Murray Street and lands of the Elevated Railway Company. For a length of 340 feet in Murray Street the relocated sewer is 2 feet 10 inches wide by 3 feet 6 inches in height, of a modified horseshoe section. From Murray Street to Eliot Street, in private lands for a length of about 320 feet, two lines of cast-iron pipe, 24 inches and 30 inches in diameter, embedded in concrete, are substituted for the masonry sewer. This length passes under the incline approach to the subway. For a length of about 100 feet in Murray Street, and for the whole length in private land, the sewer is built on a pile foundation. The whole length of the detour is 660 linear feet, replacing 470 feet of original Metropolitan sewer.

The abandoned length of Metropolitan sewer in Eliot Square and Eliot Street was bulkheaded and filled with sand.

The introduction of this detour on the line of the Metropolitan sewer avoids siphoning the sewer under the subway.

The work was started by the Railway Company early in July and completed in September.

DRAINAGE FROM TANNERIES, GELATINE AND GLUE WORKS IN WINCHESTER, WOBURN AND STONEHAM.

During the year, 5 men have been employed continuously in cleaning, flushing and brushing the Metropolitan sewers in Winchester, Woburn and Stoneham above Grove Street in West Medford, near the Winchester line.

This is the territory from which large amounts of tannery and other heavy drainage are received into the Metropolitan System. The amount of this drainage is so great that during the year the Board has found it necessary to require the introduction of settling tanks of substantial size on all connections for tanneries, gelatine and glue works, both on Metropolitan and local sewers within this territory.

The ten tanneries in Winchester, Woburn and Stoneham so connected and regulated have a maximum daily capacity of 5,400 hides. About the first of this year these tanneries were handling 2,850 hides.

Gelatine and glue works in Winchester and Stoneham handle nearly 1,500 tons of raw stock.

All of the manufactories excepting two have settling tanks in use at the date of this report. These two are constructing tanks, and will have them in operation as early as the coming spring.

In the accompanying table (No. 1) is outlined the size of tanks, date of introduction and sludge already handled for the portion of the year they have been operated. It appears that about 3,000 cubic yards of semi-liquid sludge have been settled out during the part of the year tanks have been in operation. The table also indicates that when all tanks are in use and all tanneries are operating at full capacity about 8,000 cubic yards of semi-liquid sludge may be intercepted during the year.

Most of these large manufacturers have independent water supplies. The amounts of drainage measured after leaving the settling

basins are outlined in the following table (No. 2), which indicates that for considerable periods during the day a continuous sewage flow from the tanneries approximates a rate of 3,000,000 gallons per day, or nearly half the carrying capacity of all the Metropolitan sewers in the territory, and that for smaller periods it considerably exceeds one-half the carrying capacity of the sewers.

No. 1.—*Table of Semi-fluid Sludge removed from Settling Basins at the Tanneries, Gelatine and Glue Works in Winchester, Woburn and Stoneham.*

| LOCATION OF BASIN. | Basin put in Operation. | Inside Measurement of Basin (Feet). | Number of Times cleaned during Year to Jan. 1, 1911. | Average Quantity Semi-fluid Sludge removed (Cubic Yards). | Total Quantity Semi-fluid Sludge removed to Jan. 1, 1911 (Cubic Yards). | Estimated Quantity Semi-fluid Sludge to be removed Yearly (Cubic Yards). |
|---|-------------------------|-------------------------------------|--|---|---|--|
| Beggs & Cobb, Basin No. 1, . | Jan. 15, 1910 | 47.0 × 23.0 | 15 | 92 | 1,380 | 1,500 |
| Beggs & Cobb, Basin No. 2, . | May 9, 1910 | 47.0 × 23.0 | 2 | 93 | 186 | 500 |
| American Hide and Leather Company, Factory E. | Aug. 1, 1910 | 48.3 × 23.0 | 1 | 70 | 70 | 300 |
| American Hide and Leather Company, Factory D. | Nov. 15, 1910 | 48.0 × 23.1 | None | - | - | 300 |
| Cottle Leather Company, . | July 15, 1910 | 49.0 × 23.2 | 5 | 72 | 360 | 800 |
| B. F. Kimball & Co., . | Dec. 10, 1910 | 47.2 × 23.0 | None | - | - | 500 |
| E. Cummings Leather Company, | Nov. 1, 1910 | 45.9 × 22.6 | 1 | 34 | 34 | 300 |
| W. P. Fox & Sons, . . . | July 12, 1910 | 47.8 × 22.6 | 4 | 60 | 240 | 700 |
| T. F. Boyle & Co., . . . | Sept. 15, 1910 | 48.1 × 23.1 | 1 | 92 | 92 | 500 |
| Champion Tanning Company, . | Not completed | 46.8 × 22.9 | None | - | - | 200 |
| Stoneham Tanning Company, . | Not completed | - | - | - | - | 1,200 |
| American Glue Company, . | Oct. 1, 1910 | 47.1 × 23.0 | 1 | 90 | 90 | 400 |
| Winchester Manufacturing Company. | 1902 | { 35.5 × 24.7 67.2 × 12.0 } | 7 | 64 | 448 | 600 |
| Total, | - | - | - | - | 2,900 | 7,800 |

No. 2.—Weir Measurements of Manufacturing Drainage entering the Metropolitan Sewer from Settling Basins at Tanneries, Gelatine and Glue Works in Winchester, Woburn and Stoneham.

| NAME. | Weir Measurements (Gallons per 24 Hours). | | Maximum Rate of Flow (Gallons per 24 Hours), 1910. | Average Rate of Flow for Nine-hour Day Period (8 A.M. to 5 P.M.) (Gallons per 24 Hours), 1910. | Estimated Per Cent. of Present Business to Maximum Capacity. | Estimated Rate of Flow for Nine-hour Day Period of Maximum Business Capacity (Gallons per 24 Hours). |
|---|--|----------------------|---|---|--|--|
| | 1909. | 1910. | | | | |
| Beggs & Cobb, Basin No. 1, | 213,000 | 127,000 | 565,000 | 266,700 | 66½ | 400,000 |
| Beggs & Cobb, Basin No. 2, | | 57,000 | 465,000 | 112,400 | 66½ | 170,000 |
| American Hide and Leather Company, Factory E. | 40,000 ¹ | 40,000 | 87,000 | 59,000 | 66½ | 90,000 |
| American Hide and Leather Company, Factory D. | 50,000 ¹ | 2,000 ¹ | 150,000 ¹ | 2,000 ¹ | — ² | 75,000 |
| Cottle Leather Company, | 50,000 ¹ | 1,000 ¹ | 150,000 ¹ | 1,000 ¹ | — ² | 100,000 |
| B. F. Kimball & Co., | 75,000 ¹ | 75,000 | 292,000 | 157,100 | 100 | 170,000 |
| E. Cummings Leather Company, . . . | 52,000 ¹ | 52,000 | 141,000 | 100,100 | 80 | 125,000 |
| W. P. Fox & Sons, | 80,000 ¹ | 66,000 | 356,000 | 124,300 | 57 | 220,000 |
| T. F. Boyle & Co., | 120,000 ¹ | 116,000 | 458,000 | 254,900 | 100 | 275,000 |
| Champion Tanning Company, . . . | 50,000 ¹ | 38,000 | 142,000 | 72,300 | 22 | 125,000 |
| Stoneham Tanning Company, . . . | 150,000 ¹ | 100,000 ¹ | 500,000 ¹ | 250,000 ¹ | 50 | 500,000 |
| American Glue Company, | 134,000 | 83,000 | 259,000 | 60,000 | 100 | 150,000 |
| Winchester Manufacturing Company, . | 158,000 | 145,000 | 691,000 | 294,000 | 100 | 300,000 |
| Total, | 1,172,000 | 902,000 | 4,256,000 | 1,753,800 | — | 2,700,000 |

¹ Estimated.

² Not tanning.

SOUTH METROPOLITAN SYSTEM.

SOUTH METROPOLITAN OUTFALLS.

The 60-inch outfall pipes in the harbor have been in operation six years at the date of this report. These pipes are in normal condition and free from deposit. During the past year the average flow through them has been 39,600,000 gallons of sewage per day, with a maximum rate of 141,000,000 gallons in the month of January, 1910.

Material Intercepted at the Screens.

The material intercepted at the screens at the North Metropolitan sewerage stations, consisting of rags, paper and other floating mat-

ters, has during the year amounted to 2,335 cubic yards. This is equivalent to 2.7 cubic feet for each million gallons of sewage pumped at Deer Island.

The material intercepted at the screens at the South Metropolitan sewerage stations has amounted to 2,312 cubic yards, equal to 4.3 cubic feet per million gallons of sewage delivered at the outfall works at Nut Island.

Studies of sewage flows in the Metropolitan sewers, siphons and outfall pipes indicate that they are free from deposit.

Respectfully submitted,

WM. M. BROWN,

Chief Engineer of Sewerage Works.

BOSTON, January 2, 1911.

APPENDIX.

APPENDIX No. 1.

CONTRACTS MADE AND PENDING DURING

[NOTE.—The details of contracts made before

| 1. Num- ber of Con- tract. | 2. WORK. | 3. Num- ber of Bids. | AMOUNT OF BID. | | 6. Contractor. |
|--|---|----------------------------------|--|--|---|
| | | | 4. Next to Lowest. | 5. Lowest. | |
| 1 302 ¹ | 4,000 tons 60-inch cast-iron water pipes. | 1 | - | \$98,800 00 ² | United States Cast Iron Pipe and Foundry Co., Philadelphia, Pa. |
| 2 305 ¹ | 4,000 tons 60-inch cast-iron water pipes. | 1 | - | 98,800 00 ² | Florence Iron Works, Camden, N. J. |
| 3 306 ¹ | 200 tons special castings. | 2 | \$14,640 00 | 9,400 00 ² | Standard Cast Iron Pipe and Foundry Co., Bristol, Pa. |
| 4 310 ¹ | Laying 8,070 feet of 60-inch water pipes in Boston and Newton, Sect. 8 of the Weston Aqueduct supply mains. | 10 | 37,044 50 | 34,908 60 ² | Charles J. Jacobs Co., Boston. |
| 5 312 | 40-million-gallon pumping engine. | 4 | 105,700 00 | 99,769 00 ² | Holly Mfg. Co., Buffalo, N. Y. |
| 6 313 ¹ | 32 tons 4-inch to 10-inch cast-iron water pipes, 80 tons special castings. | 4 | 5,508 40 | 4,854 40 ² | United States Cast Iron Pipe and Foundry Co., Philadelphia, Pa. |
| 7 314 | Building pressure tunnel about 1,900 feet in length, and laying 500 feet of 80-inch steel pipe and 930 feet of 60-inch pipe in Newton, Sect. 7 of the Weston Aqueduct supply mains. | 9 | 105,201 00 | 102,150 00 ² | Joseph Hanreddy, Chicago, Ill. |
| 8 315 ¹ | 159 tons 48-inch cast-iron water pipes. | 3 | 4,173 75 ² | 4,046 55 | Warren Foundry and Machine Co., New York, N. Y. |
| 9 316 ¹ | Laying 4,720 feet of 16-inch water pipes in Lynn, Sect. 35 of the distribution system. | 13 | 3,968 30 | 3,953 40 ² | Charles M. Callahan, Boston. |
| 10 317 ¹ | 210 tons 16-inch cast iron water pipes. | 4 | 5,334 00 | 5,271 00 ² | United States Cast Iron Pipe and Foundry Co., Philadelphia, Pa. |
| 11 318 ¹ | 1,405 tons cast-iron water pipes: 425 tons 48-inch, 860 tons 36-inch, 120 tons 30-inch. | 3 | 35,646 25 ² 35,450 25 ² | 35,265 50 ² 34,579 50 ² | United States Cast Iron Pipe and Foundry Co., Philadelphia, Pa. |

¹ Contract completed.² Contract based upon this bid.³ Joint bid for 8,000 tons was made for contracts Nos. 302 and 305.

APPENDIX No. 1.

THE YEAR 1910—WATER WORKS.

1910 have been given in previous reports.]

| 7. Date of Con- tract. | 8. Date of Completion of Work. | 9. Prices of Principal Items of Contracts made in 1910. | 10. Value of Work done Dec. 31, 1910. | |
|------------------------------|---|--|--|----|
| May 14, 1909 | Mar. 14, 1910 | — | \$100,931 88 | 1 |
| May 14, 1909 | Sept. 28, 1910 | — | 100,549 39 | 2 |
| May 14, 1909 | Apr. 21, 1910 | — | 8,757 20 | 3 |
| Aug. 18, 1909 | Aug. 10, 1910 | — | 40,525 39 | 4 |
| Sept. 21, 1909 | — | — | 90,000 00 | 5 |
| Jan. 26, 1910 | Aug. 10, 1910 | 4-inch, 8-inch and 10-inch pipe \$26.70; special castings \$50 per ton of 2,000 pounds. | 4,459 29 | 6 |
| Apr. 28, 1910 | — | Top soil excavation, \$0.60 per cu. yd.; top soil surfacing \$0.50 per cu. yd.; earth excavation in open trenches, \$0.50 per cu. yd.; rock excavation in open trenches, \$3.25 per cu. yd.; refilling open trenches and building embankments, \$0.50 per cu. yd.; tunnel excavation, \$25 per lin. ft.; crushing stone, \$0.75 per cu. yd.; concrete masonry in tunnel, \$10 per cu. yd.; concrete masonry in open trench, \$6 per cu. yd.; brick masonry, \$15 per cu. yd.; cement grout in tunnel, \$12 per cu. yd.; cement mortar lining for steel pipe, \$5.50 per lin. ft.; laying 80-inch steel pipe, \$3 per lin. ft.; laying 60-inch cast-iron pipe, \$2 per lin. ft. | 65,385 41 | 7 |
| Mar. 14, 1910 | Apr. 30, 1910 | 48-inch pipe \$26.25 per ton of 2,000 pounds, . . . | 4,769 04 | 8 |
| Apr. 22, 1910 | June 30, 1910 | Laying 16-inch cast-iron pipe, \$0.77 per lin. ft., . . . | 4,518 30 | 9 |
| Apr. 5, 1910 | June 10, 1910 | 16-inch pipe \$25.10 per ton of 2,000 pounds, . . . | 5,375 50 | 10 |
| Apr. 5, 1910 | Oct. 15, 1910 | 48-inch, 36-inch, 30-inch and 20-inch pipe \$25.10 per ton of 2,000 pounds delivered by rail; 36-inch and 30-inch pipe \$24.40 per ton of 2,000 pounds delivered by water. | 36,831 30 | 11 |

* Delivery by rail.

* Delivery by water.

CONTRACTS MADE AND PENDING DURING THE

| 1. Num- ber of Con- tract. | 2. WORK. | 3. Num- ber of Bids. | AMOUNT OF BID. | | 6. Contractor. |
|---|--|----------------------------------|-----------------------------|---|---|
| | | | 4. Next to Lowest. | 5. Lowest. | |
| 1 319 ¹ | 110 tons special castings, . | 3 | \$5,797 00 | \$5,390 00 ² | Standard Cast Iron Pipe and Foundry Co., Bristol, Pa. |
| 2 320 | 2 vertical fire-tube boilers for Chestnut Hill Low Service Pumping Station. | 4 | 10,640 00 | 10,448 00 ² | Robb-Mumford Boiler Co., Boston. |
| 3 321 ¹ | 48 tons flexible jointed 48-inch pipe. | 3 | 2,640 00 | 2,400 00 ² | Warren Foundry and Machine Co., New York, N. Y. |
| 4 322 ¹ | Laying 3,780 feet of 16-inch water pipe in Arlington, Sect. 36 of the distribution system. | 14 | 4,403 00 | 3,971 50 ² | De Vincenzi and Baruffoldi, Boston, Mass. |
| 5 323 ¹ | Laying 8,830 feet of 60-inch water pipe in Newton, Sect. 6 of the Weston Aqueduct supply mains. | 9 | 36,055 60 ¹ | 30,862 50 | Cavanagh Bros., Boston, Mass. |
| 6 324 ¹ | 14 water valves: 5 36-inch hydraulic lift, 7 24-inch and 2 16-inch screw-lift valves. | 3 | 9,856 00 | 8,607 00 ² | Coffin Valve Co., Boston. |
| 7 325 | 27.8 tons 24-inch cast-iron water pipes; 103.4 tons special castings. | 4 | 8,420 12 | 5,931 16 ² | Standard Cast Iron Pipe and Foundry Co., Bristol, Pa. |
| 8 326 ¹ | Laying 3,080 feet of 36-inch and 730 feet of 30-inch water pipes in Chelsea. | 9 | 10,560 10 | 9,751 00 ² | Michael Russo, Boston. |
| 9 327 ¹ | 5 tons 4-inch and 20 tons 36-inch cast-iron water pipes; 61 tons special castings. | 4 | 3,688 50 | 3,494 50 ² | United States Cast Iron Pipe and Foundry Co., Philadelphia, Pa. |
| 10 328 | Hand travelling crane, . | 2 | 3,096 00 | 2,500 00 ² | Niles - Bement - Pond Co., Boston. |
| 11 329 | Fuel economizer, . | 2 | 1,822 00 | 1,740 00 ² | B. F. Sturtevant Co., Boston. |
| 12 330 | Hydro-electric plant at Wachusett Dam. | 7 ² | 71,550 00 | 71,500 00 ² | S. Morgan Smith Co., York, Pa. |
| 13 332 | 363 feet 80-inch riveted steel pipe. | 4 | 4,270 00 | 3,650 00 ² | Hodge Boiler Works, East Boston. |
| 14 16-M ¹ | 650 tons Davis coal: 250 tons for Arlington Pumping Station; 400 tons for Spot Pond Pumping Station. | 4 | \$3.83 and \$4.35 per ton. | \$3.70 ² and \$4.20 per ton. | New England Coal and Coke Co., Boston. |
| 15 17-M ¹ | 7,500 tons Vulcan coal for Chestnut Hill pumping stations. | 10 | \$3.70 per ton. | \$3.59 ² per ton. | Spring Coal Co., Boston. |

¹ Contract completed.² Contract based upon this bid.

YEAR 1910 — WATER WORKS — *Continued.*

| 7. Date of Con- tract. | 8. Date of Completion of Work. | 9. Prices of Principal Items of Contracts made in 1910. | 10. Value of Work done Dec. 31, 1910. | |
|------------------------------|---|---|--|----|
| Apr. 8, 1910 | Dec. 15, 1910 | Special castings \$49 per ton of 2,000 pounds, . . . | \$5,767 10 | 1 |
| Apr. 29, 1910 | - | Each boiler with vertical seams of inner and outer furnace sheets riveted \$5,224. | 10,448 00 | 2 |
| Apr. 4, 1910 | June 10, 1910 | 48-inch flexible jointed pipe 2½ cents per pound, . . . | 2,191 18 | 3 |
| May 5, 1910 | July 28, 1910 | Laying 16-inch cast-iron pipe, \$0.50 per lin. ft.; rock excavation above regular grade, \$3.40 per cu. yd. | 3,333.31 | 4 |
| June 2, 1910 | Dec. 3, 1910 | Laying 60-inch cast-iron pipe \$3.82 per lin. ft.; laying 12-inch and 18-inch cast-iron pipe for blow-offs, \$1.25 per lin. ft.; rock excavation above or below regular grade, \$8 per cu. yd.; earth excavation below regular grade, \$2 per cu. yd.; chambers for air valves \$50 each; chambers for blow-off and by-pass valves and for 36-inch valves \$60 each; concrete masonry, \$7 per cu. yd. | 40,777.77 | 5 |
| May 17, 1910 | Dec. 22, 1910 | 36-inch hydraulic lift valves, \$1,272 each; 24-inch screw-lift valves, \$273 each; 16-inch screw-lift valves, \$168 each. | 8,607 00 | 6 |
| May 18, 1910 | - | Straight pipe \$25.20 per ton of 2,000 pounds; special castings \$49, \$51 and \$54 per ton of 2,000 pounds. | 4,860 00 | 7 |
| Aug. 10, 1910 | Dec. 8, 1910 | Laying water pipes: 36-inch \$1.80, 30-inch \$1.50 per lin. ft.; rock excavation above regular grade \$6, below regular grade \$8 per cu. yd.; chambers for blow-off, by-pass and air valves \$45 each, for 30-inch and 36-inch valves \$75 each; spruce piles driven and cut off, \$0.18 per lin. ft.; spruce lumber in place for foundation, \$40 per M. feet B.M.; concrete masonry, \$6 per cu. yd. | 13,086 10 | 8 |
| July 21, 1910 | Oct. 15, 1910 | 4-inch pipe \$26.70, 36-inch pipe \$24.70 per ton of 2,000 pounds; special castings \$47 per ton of 2,000 pounds. | 3,932 64 | 9 |
| Oct. 24, 1910 | - | For whole work \$2,500, | - | 10 |
| Oct. 11, 1910 | - | For whole work \$1,740, | - | 11 |
| Dec. 3, 1910 | - | For whole work \$71,500, | - | 12 |
| Dec. 6, 1910 | - | For whole work \$3,650, | - | 13 |
| June 18, 1909 | May 25, 1910 | - - - | 2,693 34 | 14 |
| July 16, 1909 | Sept. 29, 1910 | - - - | 28,171 21 | 15 |

* Includes separate and combined bids for hydraulic and electric plant.

CONTRACTS MADE AND PENDING DURING THE

| 1. Num- ber of Con- tract. | 2. WORK. | 3. Num- ber of Bids. | AMOUNT OF BID. | | 6. Contractor. |
|--|--|----------------------------------|----------------------------|--|---|
| | | | 4. Next to Lowest. | 5. Lowest. | |
| 1 19-M | Improvement of Lake Cochituate, Surface Water Drains in Framingham, Natick and Wayland. | 7 | \$31,298 00 | \$30,981 00 ² | The Henry Spinach Contracting Co., Waterbury, Conn. |
| 2 20-M | 950 tons New River or Pocahontas coal; 250 tons for Arlington Pumping Station; 700 tons for Spot Pond Pumping Station. | 3 | \$4.55 and \$4.90 per ton. | \$4.20 ³ and \$4.85 per ton. | New England Coal and Coke Co., Boston. |
| 3 21-M | 4,000 tons Beaver Run coal for Chestnut Hill Pumping stations. | 7 | \$3.84 per ton. | \$3.83 ³ per ton. | Gorman-Leonard Coal Co., Worcester, Mass. |
| 4 22-M | Sale and purchase of electrical energy to be developed at Wachusett Dam. | 3 | - | \$5.30 ⁷ per M. kilowatt hours. | Connecticut River Transmission Co., Boston. |
| 5 Special ¹ Order. | 5 steel cylinders for tunnel shafts. | 4 | 970 00 | 838 00 ² | Hodge Boiler Works, East Boston. |
| 6 Special ¹ Order. | Steel chambers for Venturi meter registers. | 2 | 996 00 | 700 00 ² | Daniel Russell Boiler Works, Boston. |
| 7 Special ¹ Order. | Steelwork for chambers. | 3 | 870 00 | 630 00 ² | James ⁸ Russell Boiler Works, Boston. |
| 8 Special ¹ Order. | 1 Type D register and chart recorder for Venturi meter. | - ⁸ | - ⁸ | - ⁸ | Builders Iron Foundry, Providence, R. I. |
| 9 Special Order. | Erecting boilers at Chestnut Hill Pumping Station. | 2 | 660 00 | 600 00 ² | F. Knight & Son, Boston. |
| 10 Special Order. | 2 ⁹ smoke flues at Chestnut Hill Pumping Station. | 4 | 555 00 | 536 00 ² | B. F. Sturtevant Co., Boston. |

¹ Contract completed.² Contract based upon this bid.

YEAR 1910—WATER WORKS—*Concluded.*

| 7. Date of Con- tract. | 8. Date of Completion of Work. | 9. Prices of Principal Items of Contracts made in 1910. | 10. Value of Work done Dec. 31, 1910. |
|------------------------------|---|--|--|
| June 22, 1910 | - | Earth excavation: for open channel, \$1.10 per cu. yd., for covered drains, \$0.90 per cu. yd.; borrowed earth, \$0.30 per cu. yd.; rock excavation, \$10 per cu. yd.; concrete masonry, \$7 per cu. yd.; furnishing and laying vitrified clay pipe: 24-inch, \$1.10 per lin. ft., 18-inch, \$1 per lin. ft., 12-inch, \$0.50 per lin. ft.; spruce lumber in place, \$33 per M. feet B. M.; stone paving, \$1.50 per sq. yd.; gravel for slopes of open channel, \$1.50 per cu. yd.; manholes \$40 each; catch basins \$55 each. | \$30,674 52 1 |
| July 25, 1910 | - | \$4.20 per ton of 2,240 pounds delivered on cars at the Arlington Pumping Station; \$4.85 per ton of 2,240 pounds delivered in bins at the Spot Pond Pumping Station. | 3,587 00 2 |
| Aug. 18, 1910 | - | \$3.83 per ton of 2,240 pounds delivered on cars at Chestnut Hill Pumping Stations. | 5,756 00 3 |
| Sept. 14, 1910 | - | Estimated minimum amount of electrical energy available per year, 5,250,000 kilowatt hours. | - 4 |
| June 30, 1910 | Aug. 10, 1910 | - - | 833 00 5 |
| July 28, 1910 | Oct. 29, 1910 | Each complete chamber, \$175, | 698 00 6 |
| July 28, 1910 | Oct. 27, 1910 | Steelwork for chambers: for 36-inch valves, \$45 for each complete set; for 36-inch hydraulic valves, \$60 for each complete set. | 690 00 7 |
| Aug. 11, 1910 | Oct. 12, 1910 | - - | 525 00 8 |
| Dec. -, 1910 | - | - - | - 9 |
| Dec. 23, 1910 | - | Flue from boiler to economizer, \$478; from economizer to chimney, \$58. | - 10 |
| | | | \$628,733 87 |

⁷ Highest bid.⁸ Competitive bids were not received.

CONTRACTS MADE AND PENDING DURING THE YEAR 1910—WATER WORKS
—Concluded.

Summary of Contracts.¹

| | Value of Work done Dec. 31, 1910. |
|---|---|
| Wachusett Department, 2 contracts, | - |
| Distribution Department, 22 contracts, | \$555,105 80 |
| 302 contracts completed from 1896 to 1909, inclusive, | 16,075,309 64 |
| | <hr/> |
| | \$16,630,415 44 |
| Deduct for work done on 11 Sudbury Reservoir contracts by the City of Boston, | 512,000 00 |
| Total of 337 contracts, | <hr/> \$16,118,415 44 |

¹ In this summary, contracts charged to maintenance are excluded.

APPENDIX NO. 2.

TABLE No. 1.—*Monthly Rainfall in Inches at Various Places on the Metropolitan Water Works, in 1910.*

| PLACE. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Total. |
|---|------------|-----------|--------|--------|------|-------|-------|---------|------------|----------|-----------|-----------|--------|
| | Princeton, | 5.43 | 4.64 | 3.44 | 3.28 | 4.23 | 1.82 | 3.45 | 2.86 | 1.36 | 4.23 | 2.21 | 38.34 |
| Jefferson, | 6.99 | 5.63 | 1.23 | 3.09 | 1.89 | 3.86 | 1.16 | 3.98 | 2.78 | 1.23 | 4.21 | 2.73 | 38.73 |
| Sterling, | 5.29 | 5.62 | 0.81 | 2.77 | 1.68 | 4.83 | 1.59 | 3.91 | 2.66 | 1.51 | 4.16 | 1.98 | 36.81 |
| Boyiston, | 5.72 | 5.12 | 0.92 | 2.76 | 1.67 | 4.52 | 1.53 | 4.13 | 3.14 | 1.49 | 4.10 | 2.43 | 37.53 |
| Sudbury Dam, Wachusett Watershed. | 5.28 | 4.95 | 0.89 | 2.83 | 1.26 | 4.11 | 1.88 | 2.24 | 2.16 | 1.87 | 3.90 | 2.39 | 33.79 |
| Framingham, | 4.98 | 5.10 | 0.77 | 2.72 | 1.34 | 4.81 | 1.76 | 2.26 | 2.57 | 1.88 | 4.02 | 2.43 | 34.64 |
| Ashland Dam, Sudbury Watershed. | 5.45 | 4.95 | 0.91 | 2.61 | 1.16 | 5.06 | 2.37 | 2.86 | 2.58 | 1.71 | 4.04 | 2.64 | 36.34 |
| Cordaville, | 5.87 | 5.20 | 0.84 | 2.82 | 1.40 | 4.75 | 2.11 | 3.11 | 2.63 | 1.96 | 4.57 | 2.51 | 37.77 |
| Lake Cochituate, | 5.11 | 5.16 | 0.77 | 2.71 | 1.33 | 4.51 | 2.23 | 1.58 | 2.50 | 1.80 | 4.16 | 2.61 | 34.47 |
| Chestnut Hill Reservoir, | 6.11 | 5.69 | 1.16 | 3.57 | 2.03 | 5.36 | 1.93 | 1.18 | 2.65 | 1.69 | 4.77 | 2.91 | 39.05 |
| Spot Pond, | 4.80 | 4.84 | 1.02 | 2.68 | 1.32 | 4.59 | 1.47 | 1.19 | 2.38 | 1.13 | 3.71 | 2.28 | 31.41 |
| Average of all, | 5.55 | 5.17 | 0.97 | 2.91 | 1.67 | 4.60 | 1.80 | 2.72 | 2.63 | 1.60 | 4.17 | 2.47 | 36.26 |
| Average, Wachusett watershed, | 5.86 | 5.24 | 1.09 | 3.01 | 2.13 | 4.36 | 1.52 | 3.87 | 2.86 | 1.40 | 4.17 | 2.34 | 37.85 |
| Average, Sudbury watershed, | 5.39 | 5.06 | 0.85 | 2.75 | 1.29 | 4.68 | 2.03 | 2.62 | 2.49 | 1.86 | 4.13 | 2.49 | 35.64 |

TABLE NO. 2.—Rainfall in Inches at Jefferson, Mass., in 1910.

| DAY OF MONTH. | | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | | |
|---------------|---|----------|-----------|-------------------|-------------------|------|-------|-------|---------|------------|----------|-------------------|-------------------|------|------|
| 1, | . | . | . | 0.34 | - | - | - | - | - | 0.30 | - | - | - | | |
| 2, | . | . | . | - | - | - | - | - | 0.55 | - | - | - | - | | |
| 3, | . | . | . | - | - | - | - | - | - | 0.65 | - | - | - | | |
| 4, | . | . | . | 0.38 ¹ | - | - | - | - | 0.54 | - | - | 2.20 | - | | |
| 5, | . | . | . | - | - | - | - | - | - | - | - | - | - | | |
| 6, | . | . | . | - | - | - | - | 0.89 | - | - | 0.94 | - | - | | |
| 7, | . | . | . | 1.99 ¹ | - | 0.72 | - | - | - | - | 0.20 | - | - | | |
| 8, | . | . | . | - | - | - | - | - | - | - | - | - | - | | |
| 9, | . | . | . | - | 0.38 ¹ | - | - | 0.36 | - | - | - | 0.24 | - | | |
| 10, | . | . | . | - | - | - | - | - | - | - | - | - | 0.24 | | |
| 11, | . | . | . | - | - | 0.51 | - | 1.77 | - | 1.72 | - | - | - | | |
| 12, | . | . | . | - | 1.79 ¹ | - | - | - | 0.80 | - | - | - | - | | |
| 13, | . | . | . | - | - | - | - | - | 0.18 | - | - | - | - | | |
| 14, | . | . | . | - | - | - | - | 0.19 | - | 0.15 | - | - | - | | |
| 15, | . | . | . | 1.29 ¹ | - | - | - | - | - | 0.27 | - | 0.07 | - | | |
| 16, | . | . | . | - | - | - | - | - | - | 0.29 | - | - | - | | |
| 17, | . | . | . | - | 1.28 ¹ | - | - | - | 0.40 | - | - | - | - | | |
| 18, | . | . | . | 0.51 ¹ | - | - | 0.89 | 0.31 | - | - | - | - | - | | |
| 19, | . | . | . | - | - | - | - | - | - | 0.55 | - | - | 0.17 | | |
| 20, | . | . | . | - | - | 0.17 | - | - | - | - | - | - | 0.04 ¹ | | |
| 21, | . | . | . | - | 0.54 | - | - | 0.11 | - | - | - | - | 0.35 ¹ | | |
| 22, | . | . | . | 1.44 | 0.73 ¹ | - | 0.14 | - | - | - | - | 0.34 | 0.14 | | |
| 23, | . | . | . | - | 0.08 ¹ | - | - | - | - | - | - | - | - | | |
| 24, | . | . | . | - | - | - | - | - | - | - | 0.17 | - | 1.32 | | |
| 25, | . | . | . | - | 0.74 ¹ | - | 1.00 | 0.27 | - | - | - | 0.13 | 0.17 ¹ | | |
| 26, | . | . | . | - | - | - | 0.38 | - | - | 0.06 | - | - | - | | |
| 27, | . | . | . | - | 0.14 ¹ | - | - | - | - | - | 0.25 | - | - | | |
| 28, | . | . | . | - | 0.40 | - | - | - | 0.33 | - | 0.48 | - | 0.14 | | |
| 29, | . | . | . | - | 0.88 ¹ | - | 0.17 | - | - | - | - | 1.40 ¹ | 0.36 | | |
| 30, | . | . | . | - | - | - | - | - | 0.50 | - | - | - | - | | |
| 31, | . | . | . | - | - | - | - | 0.38 | - | - | - | - | - | | |
| Totals, | . | . | . | 6.99 | 5.55 | 1.23 | 3.09 | 1.89 | 3.86 | 1.16 | 3.98 | 2.78 | 1.23 | 4.21 | 2.73 |

Total for the year 38.73 inches.

¹ Snow.² Rainfall included in that of following day.³ Rain and snow.

TABLE No. 3.—Rainfall in Inches at Framingham, Mass., in 1910.

| DAY OF MONTH. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. |
|---------------|-------------------|-------------------|-------------------|-------------------|------|-------|-------|---------|------------|----------|-----------|-------------------|
| 1, | - | - | 1 | - | 0.03 | - | - | 0.45 | - | - | - | - |
| 2, | - | - | 0.20 | - | 0.03 | - | - | - | - | - | - | - |
| 3, | 0.02 ¹ | 2 | - | - | 2 | 0.05 | - | - | 0.45 | - | 2 | - |
| 4, | - | 0.47 ² | - | 0.02 | 2 | - | - | 0.38 | - | - | 2 | - |
| 5, | - | - | - | - | 0.23 | 2 | - | - | 0.51 | - | 2.29 | - |
| 6, | - | - | - | - | - | 2 | - | - | 0.72 | - | - | 2 |
| 7, | 1.84 ² | - | 0.38 | 2 | - | 1.07 | - | - | - | 0.13 | - | 0.37 ¹ |
| 8, | - | - | - | 0.25 | 2 | - | 0.05 | - | - | - | - | - |
| 9, | - | 0.23 ² | - | 0.02 | 0.25 | 2 | - | - | - | 0.47 | 2 | - |
| 10, | - | - | - | - | 0.01 | 2 | - | 2 | - | - | 0.31 | - |
| 11, | - | 2 | - | 0.30 | - | 2 | - | 1.08 | - | - | - | - |
| 12, | - | 1.64 ² | - | - | - | 2.45 | - | - | - | - | - | - |
| 13, | - | 2 | - | 0.06 ² | - | - | 0.19 | - | - | - | - | - |
| 14, | - | 2 | - | - | - | - | - | - | - | 2 | - | - |
| 15, | 0.93 ¹ | - | - | - | 0.02 | - | - | 2 | - | 0.20 | - | 0.03 ¹ |
| 16, | - | 2 | - | - | - | 2 | 0.23 | 0.08 | - | - | - | - |
| 17, | - | 2 | 0.92 ² | 0.02 ¹ | 2 | - | 0.78 | - | - | - | - | - |
| 18, | - | 0.29 ² | - | - | 2 | 0.31 | 0.33 | - | 2 | - | - | 2 |
| 19, | - | - | - | 2 | - | - | - | 0.57 | 2 | - | - | 0.13 |
| 20, | - | - | 0.07 | 0.75 | 2 | - | - | - | 0.07 | 0.11 | - | 0.40 ¹ |
| 21, | - | 2 | 0.49 | - | 2 | 0.07 | - | - | - | 0.05 | - | 0.01 ² |
| 22, | - | 0.59 | 0.52 ² | - | 0.44 | 2 | - | - | - | 2 | - | - |
| 23, | - | - | - | - | - | 0.04 | - | - | - | 0.56 | - | 2 |
| 24, | - | - | - | - | - | 0.06 | - | - | 0.11 | - | - | 1.27 |
| 25, | - | 0.48 ² | - | - | - | 0.02 | - | 0.46 | - | - | 0.35 | 0.19 |
| 26, | - | 2 | - | - | 0.88 | - | - | 0.13 | - | - | - | 0.05 ² |
| 27, | - | 0.10 ² | 2 | - | - | 2 | 2 | - | 2 | 2 | - | - |
| 28, | - | 2 | 0.83 | - | - | 0.04 | 0.04 | 0.35 | 2 | 0.21 | 0.06 | 2 |
| 29, | - | 0.70 ² | - | - | 2 | - | - | - | 0.02 | - | - | - |
| 30, | - | 2 | - | - | 0.06 | 2 | - | 0.48 | - | - | - | 1.23 ² |
| 31, | - | 0.03 ¹ | - | 0.04 | - | 0.32 | - | - | - | - | - | - |
| Totals, | 4.98 | 5.10 65 | 0.77 | 2.72 | 1.34 | 4.81 | 1.76 | 2.26 | 2.57 | 1.88 | 4.02 | 2.43 |

Total for the year 34.64 inches.

¹ Snow.² Rainfall included in that of the following day.³ Rain and snow.

TABLE No. 4.—Rainfall in Inches at Chestnut Hill Reservoir in 1910.

| DATE. | Amount. | Duration. | DATE. | Amount. | Duration. |
|------------|-------------------|--------------------------|-------------|---------|---------------------------------------|
| Jan. 3, . | .09 ¹ | 10.15 A.M. to 2.15 P.M. | May 2, . | .03 | 4.20 A.M. to 4.35 A.M. |
| Jan. 5, . | .206 ² | 8.00 A.M. to 1.00 P.M. | May 4, . | .09 | 4.30 P.M. to 2.30 P.M. |
| Jan. 7, . | .05 ¹ | 4.20 A.M. to 7.30 A.M. | May 5, . | .20 | 2.30 P.M. to 2.30 P.M. |
| Jan. 10, . | .05 ¹ | 12.45 A.M. to 1.00 P.M. | May 9, . | .05 | 2.30 P.M. to 11.10 A.M. to 12.50 P.M. |
| Jan. 14, . | 1.43 ¹ | 2.15 A.M. to 1.15 A.M. | May 15, . | .37 | 11.20 A.M. to 7.20 P.M. |
| Jan. 15, . | .40 ² | 4.15 P.M. to 5.45 P.M. | May 18, . | .21 | 4.45 A.M. to 8.00 P.M. |
| Jan. 18, . | .73 | 3.10 P.M. to 11.45 P.M. | May 21, . | .08 | 11.40 A.M. to 12.10 A.M. |
| Jan. 22, . | .05 ² | 12.30 A.M. to 2.55 A.M. | May 26, . | .04 | 11.30 A.M. to 9.00 A.M. |
| Jan. 25, . | .80 | 10.40 P.M. to 10.30 P.M. | May 27, . | .03 | 11.40 A.M. to 11.50 P.M. |
| Jan. 27, . | .03 ¹ | 7.55 P.M. to 10.15 P.M. | May 28, . | .68 | 11.30 A.M. to 11.40 A.M. |
| Jan. 30, . | .03 ¹ | | May 31, . | .05 | 7.35 P.M. to 9.30 P.M. |
| Total, . | 6.11 | | Total, . | 2.03 | |
| Feb. 3, . | .60 | 7.00 P.M. to 2.45 A.M. | June 5, . | 1.11 | 10.45 P.M. to 5.15 P.M. |
| Feb. 4, . | .25 ¹ | 2.45 A.M. to 3.15 P.M. | June 7, . | 3.40 | 10.40 P.M. to 10.30 P.M. |
| Feb. 9, . | .21 | 7.10 P.M. to 11.20 P.M. | June 9, . | .81 | 10.00 A.M. to 2.10 P.M. |
| Feb. 11, . | 1.52 ¹ | 9.00 P.M. to 9.10 A.M. | June 16, . | .04 | 12.40 A.M. to 8.30 A.M. |
| Feb. 12, . | .03 | 9.10 A.M. to 5.30 P.M. | June 17, . | | |
| Feb. 17, . | .92 ² | 2.05 A.M. to 5.00 A.M. | June 28, . | | |
| Feb. 18, . | .58 | 2.45 A.M. to 11.35 P.M. | Total, . | 5.36 | |
| Feb. 21, . | .57 ² | 9.05 A.M. to 8.30 P.M. | July 8, . | .10 | 6.05 A.M. to 7.15 A.M. |
| Feb. 22, . | 1.01 | 9.45 P.M. to 8.00 A.M. | July 13, . | .11 | 1.15 P.M. to 2.15 P.M. |
| Mar. 1, . | | | July 16, . | .43 | 1.00 P.M. to 11.35 P.M. |
| Total, . | 5.69 | | July 25, . | .51 | 5.00 P.M. to 8.45 P.M. |
| Mar. 1, . | .29 | 8.00 A.M. to 4.30 P.M. | July 28, . | .28 | 2.35 A.M. to 5.40 A.M. |
| Mar. 2, . | .65 | 9.00 P.M. to 10.30 A.M. | July 30, . | .29 | 9.50 A.M. to 11.20 A.M. |
| Mar. 6, . | | | July 30, . | .21 | 4.30 P.M. to 5.30 P.M. |
| Mar. 7, . | .08 | 12.15 A.M. to 1.55 A.M. | Total, . | 1.93 | |
| Mar. 14, . | .04 | 6.15 P.M. to 10.30 P.M. | Aug. 4, . | .13 | 12.30 P.M. to 8.30 P.M. |
| Mar. 20, . | .10 | 7.55 P.M. to 10.00 P.M. | Aug. 10, . | .19 | 6.15 P.M. to 8.00 A.M. |
| Total, . | 1.16 | | Aug. 11, . | .09 | 6.45 P.M. to 10.00 P.M. |
| Apr. 4, . | .02 | 4.30 P.M. to 7.20 P.M. | Aug. 19, . | .53 | 12.50 A.M. to 9.25 A.M. |
| Apr. 7, . | .49 | 11.20 P.M. to 9.50 P.M. | Aug. 26, . | .24 | 10.35 A.M. to 10.45 A.M. |
| Apr. 8, . | | | Total, . | 1.18 | |
| Apr. 11, . | .34 | 6.30 P.M. to 12.10 A.M. | Sept. 1, . | .69 | 8.05 A.M. to 7.00 P.M. |
| Apr. 12, . | .90 | 7.30 P.M. to 5.15 A.M. | Sept. 3, . | .61 | 3.05 P.M. to 12.00 M. |
| Apr. 17, . | .05 | 8.00 P.M. to 5.00 A.M. | Sept. 5, . | .41 | 12.50 A.M. to 12.10 A.M. |
| Apr. 19, . | .05 | 2.40 A.M. to 11.30 A.M. | Sept. 6, . | .46 | 6.45 P.M. to 11.20 P.M. |
| Apr. 20, . | .58 | 5.35 A.M. to 10.45 P.M. | Sept. 21, . | .25 | 4.50 A.M. to 5.40 A.M. |
| Apr. 22, . | 1.11 | 11.15 P.M. to 8.00 A.M. | Sept. 24, . | .04 | 5.50 P.M. to 12.15 A.M. |
| Apr. 26, . | .08 | | Sept. 25, . | .19 | 12.50 A.M. to 8.15 A.M. |
| Total, . | 3.57 | | Sept. 28, . | | |

¹ Snow.² Rain and snow.

TABLE NO. 4.—*Rainfall in Inches at Chestnut Hill Reservoir in 1910—Concluded.*

| DATE. | Amount. | Duration. | DATE. | Amount. | Duration. |
|------------|---------|-------------------------|------------|------------------|--------------------------|
| Oct. 7, . | .21 | 10.15 A.M. to 9.00 P.M. | Dec. 6, . | .56 ¹ | 11.15 A.M. to 8.00 A.M. |
| Oct. 9, . | .31 | 5.40 P.M. to 9.20 P.M. | Dec. 7, . | .56 ¹ | 2.45 P.M. to 12.10 A.M. |
| Oct. 15, . | .11 | 4.00 P.M. to 8.35 P.M. | Dec. 15, . | .13 | |
| Oct. 20, . | .06 | 9.00 A.M. to 4.30 P.M. | Dec. 16, . | .13 | |
| Oct. 22, . | | 2.30 P.M. to | Dec. 18, . | .22 | 11.50 P.M. to 10.45 A.M. |
| Oct. 23, . | .69 | | Dec. 19, . | .22 | |
| Oct. 25, . | .21 | 6.45 P.M. to 7.45 P.M. | Dec. 20, . | .22 ¹ | 7.35 P.M. to 3.00 A.M. |
| Oct. 27, . | | 6.15 P.M. to | Dec. 21, . | .1.52 | 6.15 A.M. to 11.40 P.M. |
| Oct. 28, . | .10 | | Dec. 24, . | .05 ¹ | 4.30 P.M. to |
| | | 8.15 A.M. | Dec. 26, . | .05 ¹ | 12.35 A.M. |
| Total, . | 1.69 | | Dec. 27, . | .09 | 4.50 P.M. to 10.00 P.M. |
| | | | Dec. 28, . | .09 | |
| | | | Dec. 29, . | .12 | 3.40 P.M. to |
| | | | Dec. 30, . | | 8.00 A.M. |
| Nov. 2, . | | 7.50 P.M. to | Total, . | 2.91 | |
| Nov. 3, . | .52 | | | | |
| Nov. 3, . | | 7.15 P.M. to 10.45 A.M. | | | |
| Nov. 4, . | 2.30 | | | | |
| Nov. 10, . | .37 | 12.25 A.M. to 7.15 A.M. | | | |
| Nov. 10, . | .03 | 7.00 P.M. to 8.00 P.M. | | | |
| Nov. 25, . | .11 | 7.15 A.M. to 5.15 P.M. | | | |
| Nov. 29, . | | 12.20 A.M. to 4.55 A.M. | | | |
| Nov. 30, . | | | | | |
| Total, . | 4.77 | | | | |

Total for the year 39.05 inches.

¹ Snow.

² Rain and snow.

TABLE No. 5.—Rainfall in Inches on the Wachusett Watershed,¹ 1897 to 1910.

| YEAR. | January. | Febru- | March. | April. | May. | June. | July. | August. | Septem- | October. | Novem- | Decem- | Totals. |
|---------------------|----------|--------|--------|--------|-------|-------|-------|---------|---------|----------|--------|--------|---------|
| | | | | | | | | | ber. | | ber. | ber. | |
| 1897, | . | . | . | 3.46 | 2.86 | 4.01 | 2.32 | 5.06 | 5.11 | 8.65 | 3.47 | 1.93 | 0.94 |
| 1898, | . | . | . | 6.65 | 3.30 | 2.27 | 4.43 | 3.38 | 3.11 | 3.01 | 10.61 | 3.15 | 7.21 |
| 1899, | . | . | . | 2.93 | 5.12 | 6.75 | 1.94 | 1.33 | 5.51 | 3.82 | 3.20 | 4.11 | 2.72 |
| 1900, | . | . | . | 4.56 | 8.69 | 6.19 | 2.76 | 4.34 | 3.69 | 3.20 | 3.18 | 3.46 | 2.90 |
| 1901, | . | . | . | 1.75 | 1.13 | 5.82 | 9.64 | 7.02 | 1.51 | 5.66 | 4.58 | 3.10 | 3.70 |
| 1902, | . | . | . | 2.72 | 4.91 | 5.27 | 4.36 | 2.24 | 2.51 | 3.87 | 3.95 | 4.26 | 6.36 |
| 1903, | . | . | . | 2.85 | 4.42 | 6.58 | 3.10 | 1.24 | 10.37 | 3.43 | 3.88 | 2.93 | 4.43 |
| 1904, | . | . | . | 4.02 | 2.66 | 3.40 | 7.45 | 2.99 | 3.44 | 3.84 | 3.68 | 5.30 | 1.78 |
| 1905, | . | . | . | 6.10 | 1.72 | 3.95 | 2.60 | 0.83 | 4.88 | 5.39 | 3.09 | 6.90 | 1.81 |
| 1906, | . | . | . | 2.59 | 2.74 | 5.17 | 3.12 | 6.58 | 5.95 | 5.52 | 4.34 | 2.61 | 3.95 |
| 1907, | . | . | . | 2.84 | 2.32 | 1.82 | 2.65 | 2.96 | 3.54 | 3.03 | 1.26 | 9.50 | 5.68 |
| 1908, | . | . | . | 3.40 | 4.82 | 2.77 | 2.62 | 5.34 | 1.29 | 3.85 | 6.49 | 1.04 | 2.13 |
| 1909, | . | . | . | 3.52 | 6.10 | 4.38 | 5.71 | 2.65 | 3.03 | 4.25 | 3.59 | 3.90 | 1.70 |
| 1910, | . | . | . | 5.86 | 5.24 | 1.00 | 3.01 | 2.13 | 4.36 | 1.52 | 3.87 | 2.86 | 1.40 |
| Totals, | . | . | . | 53.25 | 56.03 | 59.47 | 55.71 | 48.00 | 58.20 | 59.04 | 59.19 | 55.05 | 46.71 |
| Average (14 years), | . | . | . | 3.80 | 4.00 | 4.25 | 3.98 | 3.43 | 4.16 | 4.22 | 4.23 | 3.93 | 3.34 |

¹ Means of observations at four places, as follows: January, 1897, to December, 1900, Princeton, Jefferson, Sterling and South Clinton; January, 1901, to December, 1910, Princeton, Jefferson, Sterling and Boylston.

TABLE No. 6.—Rainfall in Inches on the Sudbury Watershed,¹ 1875 to 1910.

| YEAR. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Totals. |
|-------|----------|-----------|--------|--------|------|-------|-------|---------|------------|----------|-----------|-----------|---------|
| 1875, | . | . | . | 2.42 | 3.15 | 3.74 | 3.23 | 3.56 | 6.24 | 3.57 | 5.53 | 3.43 | 4.85 |
| 1876, | . | . | . | 1.83 | 4.21 | 7.43 | 4.20 | 2.76 | 2.04 | 9.13 | 1.72 | 4.62 | 2.24 |
| 1877, | . | . | . | 3.22 | 0.74 | 8.36 | 3.43 | 3.70 | 2.43 | 2.95 | 3.68 | 0.32 | 8.52 |
| 1878, | . | . | . | 5.63 | 5.97 | 4.60 | 5.79 | 0.96 | 3.88 | 2.97 | 6.94 | 1.29 | 6.42 |
| 1879, | . | . | . | 2.48 | 3.56 | 5.14 | 4.72 | 1.58 | 3.79 | 3.93 | 6.51 | 1.88 | 0.81 |
| 1880, | . | . | . | 3.57 | 3.98 | 3.31 | 3.11 | 1.84 | 2.14 | 6.27 | 4.01 | 1.60 | 3.74 |
| 1881, | . | . | . | 5.56 | 4.65 | 5.73 | 2.00 | 3.51 | 5.39 | 2.35 | 1.36 | 2.62 | 2.95 |
| 1882, | . | . | . | 5.95 | 4.55 | 2.65 | 1.82 | 5.07 | 1.66 | 1.77 | 1.67 | 8.74 | 2.07 |
| 1883, | . | . | . | 2.81 | 3.87 | 1.78 | 1.84 | 4.19 | 2.40 | 2.68 | 0.73 | 1.52 | 5.00 |
| 1884, | . | . | . | 5.09 | 6.54 | 4.72 | 4.41 | 3.47 | 3.44 | 3.67 | 4.65 | 0.85 | 2.48 |
| 1885, | . | . | . | 4.71 | 3.87 | 1.07 | 3.60 | 3.48 | 2.87 | 1.43 | 7.18 | 1.43 | 5.09 |
| 1886, | . | . | . | 6.36 | 6.28 | 3.61 | 2.22 | 3.00 | 1.47 | 3.27 | 4.10 | 2.90 | 3.24 |
| 1887, | . | . | . | 5.20 | 4.78 | 4.90 | 4.27 | 1.16 | 2.65 | 3.76 | 5.28 | 1.32 | 2.83 |
| 1888, | . | . | . | 4.15 | 3.68 | 6.02 | 2.43 | 4.82 | 2.54 | 1.41 | 6.22 | 8.59 | 4.99 |
| 1889, | . | . | . | 5.37 | 1.65 | 2.37 | 3.41 | 2.95 | 2.80 | 8.94 | 4.18 | 4.80 | 4.25 |
| 1890, | . | . | . | 2.53 | 3.51 | 7.73 | 2.64 | 5.21 | 2.03 | 2.46 | 3.87 | 6.00 | 10.51 |
| 1891, | . | . | . | 7.02 | 5.23 | 6.48 | 3.91 | 2.01 | 3.77 | 3.39 | 4.73 | 2.38 | 8.83 |
| 1892, | . | . | . | 5.85 | 3.14 | 4.06 | 0.83 | 5.58 | 2.76 | 4.23 | 4.44 | 2.84 | 1.17 |
| 1893, | . | . | . | 2.92 | 8.20 | 3.67 | 3.60 | 6.61 | 2.38 | 2.57 | 5.41 | 1.74 | 4.07 |
| 1894, | . | . | . | 4.00 | 3.91 | 1.43 | 3.42 | 4.24 | 1.15 | 3.26 | 2.03 | 2.63 | 5.34 |

¹ See note at bottom of page 174.

TABLE No. 6.—Rainfall in Inches on the Sudbury Watershed,¹ 1875 to 1910.—Concluded.

| YEAR. | January | Febru- | March. | April. | May. | June. | July. | August. | Septem- | October. | Novem- | Decem- | Totals. | | | | |
|---------------------|---------|--------|--------|--------|--------|--------|--------|---------|---------|----------|--------|--------|---------|--------|--------|--------|----------|
| | | | | | | | | | | | | | | | | | |
| 1895, | • | • | • | • | 4.06 | 1.39 | 2.98 | 5.25 | 2.02 | 2.77 | 5.04 | 4.15 | 2.30 | 10.68 | 6.63 | 3.35 | 50.62 |
| 1896, | • | • | • | • | 2.39 | 7.18 | 5.24 | 1.57 | 2.57 | 3.22 | 2.51 | 2.40 | 7.72 | 3.76 | 3.02 | 2.12 | 43.70 |
| 1897, | • | • | • | • | 4.00 | 2.91 | 3.06 | 2.82 | 4.37 | 4.46 | 5.44 | 3.51 | 2.04 | 0.47 | 6.40 | 5.21 | 46.19 |
| 1898, | • | • | • | • | 6.83 | 4.49 | 2.40 | 4.66 | 3.22 | 2.48 | 4.09 | 8.17 | 2.62 | 6.71 | 6.93 | 3.28 | 56.88 |
| 1899, | • | • | • | • | 4.18 | 4.91 | 7.01 | 1.90 | 1.45 | 2.51 | 3.23 | 1.43 | 3.95 | 2.69 | 2.18 | 1.78 | 37.21 |
| 1900, | • | • | • | • | 4.96 | 9.14 | 6.35 | 2.58 | 4.32 | 2.99 | 2.42 | 2.26 | 3.36 | 3.83 | 5.70 | 2.74 | 50.65 |
| 1901, | • | • | • | • | 1.82 | 1.52 | 6.57 | 8.60 | 7.23 | 1.38 | 5.71 | 4.57 | 3.30 | 2.82 | 2.90 | 9.60 | 56.11 |
| 1902, | • | • | • | • | 2.52 | 6.18 | 5.34 | 4.13 | 1.86 | 2.89 | 2.04 | 3.40 | 4.64 | 4.44 | 1.45 | 6.38 | 46.07 |
| 1903, | • | • | • | • | 3.80 | 3.95 | 6.63 | 2.99 | 0.93 | 9.25 | 2.77 | 3.67 | 1.75 | 4.72 | 1.56 | 3.14 | 45.16 |
| 1904, | • | • | • | • | 4.87 | 3.00 | 2.72 | 8.87 | 2.65 | 2.80 | 1.96 | 3.86 | 5.80 | 1.64 | 1.73 | 2.92 | 42.82 |
| 1905, | • | • | • | • | 5.26 | 2.20 | 3.15 | 2.72 | 1.31 | 5.00 | 5.47 | 2.70 | 6.88 | 1.54 | 2.07 | 4.01 | 42.31 |
| 1906, | • | • | • | • | 2.47 | 2.92 | 6.32 | 2.88 | 5.66 | 3.91 | 3.42 | 3.02 | 3.30 | 3.40 | 2.69 | 4.49 | 44.48 |
| 1907, | • | • | • | • | 3.28 | 2.17 | 1.91 | 3.41 | 3.63 | 3.53 | 1.86 | 1.07 | 8.76 | 4.17 | 6.12 | 4.47 | 44.38 |
| 1908, | • | • | • | • | 3.60 | 4.56 | 3.82 | 1.88 | 5.51 | 0.86 | 3.71 | 4.57 | 0.97 | 2.55 | 0.98 | 3.14 | 36.15 |
| 1909, | • | • | • | • | 3.98 | 5.79 | 4.26 | 4.67 | 2.43 | 2.81 | 1.59 | 2.93 | 4.74 | 1.12 | 3.38 | 4.05 | 41.75 |
| 1910, | • | • | • | • | 5.39 | 5.06 | 0.85 | 2.75 | 1.29 | 4.68 | 2.03 | 2.62 | 2.49 | 1.86 | 4.13 | 2.49 | 35.64 |
| Totals, | • | • | • | • | 150.17 | 152.84 | 158.10 | 126.56 | 120.15 | 113.37 | 128.19 | 138.57 | 126.72 | 141.40 | 138.07 | 137.11 | 1,631.25 |
| Average (36 years), | • | • | • | • | 4.17 | 4.25 | 4.39 | 3.51 | 3.34 | 3.15 | 3.56 | 3.85 | 3.52 | 3.93 | 3.83 | 3.81 | 45.31 |

¹ Means of observations at several places, as follows: January, 1875, to April, 1876, Lake Cochituate; April to June, 1876, Lake Cochituate, Westborough and Hopkinton; June to December, 1876, Lake Cochituate, Southborough, Marlborough, Westborough and Hopkinton; December, 1876, to January, 1883, Framingham, Southborough, Marlborough, Westborough and Hopkinton; January, 1883, to January, 1884, to January, 1884, to December, 1884, to January, 1885, Framingham and Ashland Dam; June, 1885, to December, 1890, Framingham, Ashland Dam and Sudbury Dam.

TABLE NO. 7.—*Yield of the Wachusett Watershed in Gallons per Day per Square Mile¹ from 1897 to 1910.*

| MONTH. | 1897. | 1898. | 1899. | 1900. | 1901. | 1902. | 1903. | 1904. | 1905. | 1906. | 1907. | 1908. | 1909. | 1910. | Mean for 14 Years 1897-1910. | | |
|--------------------------------|-------|-------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|---------------------------------------|-----------|-----------|
| January, | . | . | 796,000 | 1,563,000 | 2,092,000 | 798,000 | 519,000 | 1,676,000 | 1,285,000 | 659,000 | 1,296,000 | 1,132,000 | 1,458,000 | 1,738,000 | 592,000 | 1,846,000 | 1,243,000 |
| February, | . | . | 931,000 | 1,635,000 | 1,090,000 | 4,054,000 | 356,000 | 1,401,000 | 2,133,000 | 927,000 | 452,000 | 1,027,000 | 692,000 | 1,736,000 | 2,556,000 | 1,845,000 | 1,487,000 |
| March, | . | . | 2,760,000 | 3,083,000 | 2,776,000 | 3,722,000 | 2,718,000 | 3,982,000 | 3,423,000 | 3,008,000 | 3,004,000 | 1,860,000 | 1,697,000 | 2,192,000 | 2,129,000 | 2,640,000 | 2,786,000 |
| April, | . | . | 1,632,000 | 2,027,000 | 3,376,000 | 1,580,000 | 4,986,000 | 2,159,000 | 2,233,000 | 2,984,000 | 1,617,000 | 2,109,000 | 1,436,000 | 1,269,000 | 2,422,000 | 1,034,000 | 2,205,000 |
| May, | . | . | 1,163,000 | 1,390,000 | 862,000 | 1,382,000 | 2,729,000 | 1,031,000 | 569,000 | 1,498,000 | 445,000 | 1,533,000 | 965,000 | 1,415,000 | 1,212,000 | 608,000 | 1,200,000 |
| June, | . | . | 1,181,000 | 828,000 | 561,000 | 578,000 | 985,000 | 400,000 | 2,131,000 | 762,000 | 542,000 | 1,184,000 | 773,000 | 403,000 | 632,000 | 824,000 | 842,000 |
| July, | . | . | 1,442,000 | 333,000 | 354,000 | 217,000 | 477,000 | 292,000 | 624,000 | 497,000 | 365,000 | 728,000 | 335,000 | 220,000 | 233,000 | 62,000 | 441,000 |
| August, | . | . | 896,000 | 1,325,000 | 236,000 | 197,000 | 512,000 | 297,000 | 355,000 | 321,000 | 591,000 | 87,000 | 443,000 | 193,000 | 186,000 | 437,000 | 437,000 |
| September, | . | . | 380,000 | 676,000 | 250,000 | 127,000 | 322,000 | 241,000 | 375,000 | 394,000 | 1,228,000 | 277,000 | 810,000 | 88,000 | 208,000 | 145,000 | 401,000 |
| October, | . | . | 243,000 | 1,509,000 | 245,000 | 282,000 | 647,000 | 950,000 | 689,000 | 367,000 | 530,000 | 1,382,000 | 158,000 | 90,000 | 68,000 | 536,000 | 536,000 |
| November, | . | . | 1,283,000 | 2,170,000 | 430,000 | 875,000 | 517,000 | 635,000 | 634,000 | 343,000 | 132,000 | 749,000 | 2,540,000 | 125,000 | 363,000 | 354,000 | 819,000 |
| December, | . | . | 2,275,000 | 2,061,000 | 359,000 | 1,570,000 | 3,234,000 | 1,848,000 | 954,000 | 440,000 | 1,018,000 | 794,000 | 1,961,000 | 387,000 | 537,000 | 391,000 | 1,274,000 |
| Average for year, | . | . | 1,253,000 | 1,551,000 | 1,051,000 | 1,264,000 | 1,507,000 | 1,248,000 | 1,285,000 | 1,025,000 | 926,000 | 1,043,000 | 1,180,000 | 847,000 | 918,000 | 828,000 | 1,137,000 |
| Average for driest six months, | . | . | 886,000 | 1,013,000 | 312,000 | 377,000 | 576,000 | 471,000 | 626,000 | 413,000 | 541,000 | 613,000 | 725,000 | 238,000 | 270,000 | 201,000 | 578,000 |

¹ The area of the watershed used in making up these records included water surfaces amounting to 2.2 per cent. of the whole area from 1897 to 1902, inclusive, to 2.4 per cent. in 1903, to 3.6 per cent. in 1904, to 4.1 per cent. in 1905, to 5.1 per cent. in 1906, to 6.0 per cent. in 1907, to 7.0 per cent. in 1908, 1909 and 1910.

TABLE No. 8.—*Yield of the Sudbury Watershed in Gallons per Day per Square Mile¹ from 1875 to 1910.*

| MONTH. | 1875. | 1876. | 1877. | 1878. | 1879. | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. | 1886. |
|--------------------------------|-------|-------|-------|-------|-------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| January, | . | . | . | . | . | 643,000 | 658,000 | 1,810,000 | 700,000 | 1,120,000 | 415,000 | 1,241,000 |
| February, | . | . | . | . | . | 1,496,000 | 1,388,000 | 949,000 | 2,465,000 | 1,711,000 | 1,787,000 | 1,546,000 |
| March, | . | . | . | . | . | 1,604,000 | 4,435,000 | 4,814,000 | 3,507,000 | 2,330,000 | 1,374,000 | 4,004,000 |
| April, | . | . | . | . | . | 3,049,000 | 3,292,000 | 2,394,000 | 1,626,000 | 3,116,000 | 1,169,000 | 1,546,000 |
| May, | . | . | . | . | . | 1,188,000 | 1,138,000 | 1,391,000 | 1,384,000 | 1,114,000 | 514,000 | 965,000 |
| June, | . | . | . | . | . | 870,000 | 222,000 | 597,000 | 506,000 | 413,000 | 175,000 | 1,338,000 |
| July, | . | . | . | . | . | 321,000 | 183,000 | 202,000 | 128,000 | 157,000 | 176,000 | 276,000 |
| August, | . | . | . | . | . | 396,000 | 405,000 | 121,000 | 476,000 | 395,000 | 119,000 | 148,000 |
| September, | . | . | . | . | . | 207,000 | 184,000 | 60,000 | 161,000 | 141,000 | 80,000 | 197,000 |
| October, | . | . | . | . | . | 646,000 | 234,000 | 631,000 | 516,000 | 71,000 | 102,000 | 186,000 |
| November, | . | . | . | . | . | 1,302,000 | 1,088,000 | 1,418,000 | 1,693,000 | 206,000 | 205,000 | 395,000 |
| December, | . | . | . | . | . | 584,000 | 453,000 | 1,290,000 | 3,177,000 | 463,000 | 175,000 | 775,000 |
| Average for year, | . | . | . | . | . | 972,000 | 1,135,000 | 1,214,000 | 1,452,000 | 894,000 | 578,000 | 979,000 |
| Average for driest six months, | . | . | . | . | . | 574,000 | 384,000 | 502,000 | 532,000 | 230,000 | 143,000 | 330,000 |
| | | | | | | | | | | 211,000 | 145,000 | 200,000 |
| | | | | | | | | | | | 391,000 | 391,000 |
| | | | | | | | | | | | | 223,000 |

¹ The area of the Sudbury watershed used in making up these records included water surfaces amounting to 1.9 per cent. of the whole area from 1875 to 1878, inclusive, and was subsequently increased by the construction of storage reservoirs to 3.0 per cent. in 1879, 3.4 per cent. in 1885, 3.9 per cent. in 1894 and 6.5 per cent. in 1898. The watershed also contains extensive areas of swampy land, which, though covered with water at times, are not included in the above percentages of water surfaces.

TABLE No. 8.—*Yield of the Sudbury Watershed in Gallons per Day per Square Mile¹ from 1875 to 1910—Continued.*

| MONTH. | 1887. | 1888. | 1889. | 1890. | 1891. | 1892. | 1893. | 1894. | 1895. | 1896. | 1897. | 1898. |
|--------------------------------|-------|-------|-------|-------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| January, | • | • | • | • | 2,589,000 | 1,053,000 | 2,782,000 | 1,254,000 | 3,018,000 | 1,870,000 | 434,000 | 693,000 |
| February, | • | • | • | • | 2,829,000 | 1,950,000 | 1,196,000 | 1,529,000 | 3,486,000 | 943,000 | 1,542,000 | 541,000 |
| March, | • | • | • | • | 2,868,000 | 3,238,000 | 1,338,000 | 3,643,000 | 4,453,000 | 1,945,000 | 3,245,000 | 2,238,000 |
| April, | • | • | • | • | 2,620,000 | 2,645,000 | 1,410,000 | 1,875,000 | 2,397,000 | 871,000 | 2,125,000 | 1,640,000 |
| May, | • | • | • | • | 1,009,000 | 1,632,000 | 880,000 | 1,366,000 | 583,000 | 1,259,000 | 2,883,000 | 840,000 |
| June, | • | • | • | • | 413,000 | 421,000 | 653,000 | 568,000 | 413,000 | 428,000 | 440,000 | 419,000 |
| July, | • | • | • | • | 115,000 | 117,000 | 634,000 | 107,000 | 149,000 | 214,000 | 158,000 | 161,000 |
| August, | • | • | • | • | 214,000 | 379,000 | 1,432,000 | 132,000 | 163,000 | 280,000 | 181,000 | 209,000 |
| September, | • | • | • | • | 111,000 | 1,155,000 | 823,000 | 457,000 | 203,000 | 229,000 | 108,000 | 150,000 |
| October, | • | • | • | • | 190,000 | 1,989,000 | 1,230,000 | 2,272,000 | 210,000 | 126,000 | 222,000 | 374,000 |
| November, | • | • | • | • | 369,000 | 2,758,000 | 1,941,000 | 1,215,000 | 305,000 | 697,000 | 319,000 | 836,000 |
| December, | • | • | • | • | 643,000 | 3,043,000 | 2,241,000 | 996,000 | 544,000 | 485,000 | 796,000 | 716,000 |
| Average for year, | • | • | • | • | 1,154,000 | 1,667,000 | 1,383,000 | 1,285,000 | 1,315,000 | 781,000 | 1,037,000 | 770,000 |
| Average for driest six months, | • | • | • | • | 234,000 | 953,000 | 944,000 | 747,000 | 239,000 | 327,000 | 237,000 | 356,000 |

¹ The area of the Sudbury watershed used in making up these records included water surfaces amounting to 1.0 per cent. of the whole area from 1875 to 1878, inclusive, and was subsequently increased by the construction of storage reservoirs to 3.0 per cent. in 1879, 3.4 per cent. in 1885, 3.9 per cent. in 1894, and 6.5 per cent. in 1898. The watershed also contains extensive areas of swampy land, which, though covered with water at times are not included in the above percentages of water surfaces.

METROPOLITAN WATER

[Pub. Doc.]

TABLE No. 8.—Yield of the Sudbury Watershed in Gallons per Day per Square Mile¹ from 1875 to 1910—Concluded.

| MONTH. | 1899. | 1900. | 1901. | 1902. | 1903. | 1904. | 1905. | 1906. | 1907. | 1908. | 1909. | 1910. | Mean for 36 Years, 1875-1910 |
|--------------------------------|-------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|---------------------------------------|
| January, | · · · | 2,288,000 | 794,000 | 487,000 | 1,763,000 | 1,736,000 | 477,000 | 1,410,000 | 1,128,000 | 1,351,000 | 1,925,000 | 392,000 | 1,490,000 |
| February, | · · · | 1,381,000 | 3,800,000 | 300,000 | 1,674,000 | 2,279,000 | 882,000 | 330,000 | 1,041,000 | 624,000 | 1,536,000 | 2,286,000 | 1,849,000 |
| March, | · · · | 4,205,000 | 3,654,000 | 2,755,000 | 4,196,000 | 3,454,000 | 2,999,000 | 2,497,000 | 2,409,000 | 1,653,000 | 2,257,000 | 1,734,000 | 1,954,000 |
| April, | · · · | 2,531,000 | 1,350,000 | 4,294,000 | 1,885,000 | 2,261,000 | 3,294,000 | 1,643,000 | 1,949,000 | 1,667,000 | 1,117,000 | 1,721,000 | 667,000 |
| May, | · · · | 511,000 | 1,312,000 | 2,954,000 | 743,000 | 351,000 | 1,745,000 | 297,000 | 1,059,000 | 883,000 | 1,046,000 | 1,004,000 | 277,000 |
| June, | · · · | 66,000 | 316,000 | 753,000 | 303,000 | 1,987,000 | 419,000 | 467,000 | 707,000 | 761,000 | 194,000 | 239,000 | 516,000 |
| July, | · · · | 19,000 | -18,000 | 306,000 | 66,000 | 445,000 | 62,000 | 177,000 | 398,000 | 9,000 | -14,000 | -121,000 | -102,000 |
| August, | · · · | -35,000 | -34,000 | 424,000 | 135,000 | 307,000 | 170,000 | 114,000 | 180,000 | -104,000 | 102,000 | -45,000 | -73,000 |
| September, | · · · | 94,000 | 65,000 | 305,000 | 178,000 | 130,000 | 397,000 | 1,246,000 | 19,000 | 541,000 | -82,000 | 149,000 | 5,000 |
| October, | · · · | 115,000 | 186,000 | 412,000 | 506,000 | 492,000 | 191,000 | 158,000 | 301,000 | 741,000 | 47,000 | -51,000 | -51,000 |
| November, | · · · | 304,000 | 663,000 | 474,000 | 444,000 | 363,000 | 289,000 | 279,000 | 483,000 | 1,998,000 | 71,000 | 82,000 | 176,000 |
| December, | · · · | 220,000 | 1,096,000 | 2,695,000 | 1,779,000 | 582,000 | 269,000 | 887,000 | 659,000 | 2,032,000 | 136,000 | 263,000 | 221,000 |
| Average for year, | · · · | 973,000 | 1,082,000 | 1,342,000 | 1,140,000 | 1,190,000 | 931,000 | 795,000 | 860,000 | 1,010,000 | 694,000 | 625,000 | 570,000 |
| Average for driest six months, | · · · | 93,000 | 194,000 | 445,000 | 271,000 | 388,000 | 228,000 | 403,000 | 341,000 | 471,000 | 44,000 | 40,000 | 29,000 |
| | | | | | | | | | | | | | 406,000 |

¹ The area of the Sudbury watershed used in making up these records included water surfaces amounting to 1.9 per cent. of the whole area from 1875 to 1878, inclusive, and was subsequently increased by the construction of storage reservoirs to 3.0 per cent. in 1879, 3.4 per cent. in 1885, 3.9 per cent. in 1894 and 6.5 per cent. in 1898. The watershed also contains extensive areas of swampy land—which, though covered with water at times, are not included in the above percentages of water surfaces.

NOTE.—The recorded yields, subsequent to the year 1897, are less accurate than those for previous years, due to unavoidable inaccuracies in the measurement of the quantity of water received from the Wachusett Reservoir.

TABLE No. 9.—Wachusett System.—Statistics of Flow of Water, Storage and Rainfall in 1910.

[Watershed above dam = 118.19 square miles].

| MONTH. | Quantity of Water discharged through Wachusett Aqueduct (Gallons per Day). ¹ | Quantity of Water wasted into River below Dam (Gallons per Day). | STORAGE. ² | | Total Yield of Watershed (Gallons per Day). | Rainfall (Inches). | Rainfall collected (Inches). | Percentage of Rainfall collected. |
|-------------------|---|--|-------------------------|-------------------------|---|--------------------|------------------------------|-----------------------------------|
| | | | Gain (Gallons per Day). | Loss (Gallons per Day). | | | | |
| January, | 83,661,000 | 1,558,000 | 132,184,000 | — | 218,197,000 | 5.86 | 3,293 | 56.2 |
| February, | 82,096,000 | 1,714,000 | 133,350,000 | — | 218,000,000 | 5.24 | 2,972 | 56.7 |
| March, | 77,174,000 | 1,710,000 | 232,103,000 | — | 311,958,000 | 1.09 | 4,709 | 432.8 |
| April, | 107,350,000 | 1,523,000 | 12,357,000 | — | 122,207,000 | 3.01 | 1,785 | 59.2 |
| May, | 93,697,000 | 5,045,000 | — | 27,816,000 | 71,910,000 | 2.13 | 1,085 | 50.9 |
| June, | 100,527,000 | 1,067,000 | — | 5,263,000 | 97,343,000 | 4.36 | 1,422 | 32.6 |
| July, | 131,900,000 | 2,023,000 | — | 127,574,000 | 7,310,000 | 1.52 | 0.110 | 7.2 |
| August, | 121,616,000 | 1,974,000 | — | 102,559,000 | 21,965,000 | 3.87 | 0.331 | 8.6 |
| September, | 111,493,000 | 1,943,000 | — | 97,210,000 | 17,107,000 | 2.86 | 0.250 | 8.7 |
| October, | 110,442,000 | 2,461,000 | — | 105,645,000 | 8,087,000 | 1.40 | 0.122 | 8.7 |
| November, | 97,823,000 | 2,280,000 | — | 59,020,000 | 41,883,000 | 4.17 | 0.612 | 14.7 |
| December, | 119,694,000 | 1,885,000 | — | 76,103,000 | 46,210,000 | 2.34 | 0.697 | 29.8 |
| Total, | — | — | — | — | — | 37.85 | 17,388 | — |
| Average for year, | 103,283,000 | 2,106,000 | — | 8,431,000 | 97,850,000 | — | — | 45.9 |

¹ Including 137,000 gallons per day drawn from aqueduct for the supply of the Westborough Insane Hospital.² Aggregate storage in Wachusett Reservoir and in ponds and mill reservoirs.

TABLE NO. 10.—*Sudbury System.*—Statistics of Flow of Water, Storage and Rainfall in 1910.

Watershed from 1875 to 1878 inclusive = 77,764 square miles; in 1879 and 1880 = 78,238 square miles; and from 1881 to 1910 inclusive = 75,2 square miles.

| Month. | Quantity of Water received through Wachusett Aqueduct (Gallons per Day). ¹ | Quantity of Water discharged through Sudbury Aqueduct (Gallons per Day). | Quantity of Water discharged through Weston Aqueduct (Gallons per Day). | Quantity of Water diverted from Watershed by Sewers, etc. (Gallons per Day). | Quantity of Water used by Framingham Water Works (Gallons per Day). | Quantity of Water wasted into River below Lowest Dam (Gallons per Day). | Storage. | | Total Yield of Watershed (Gallons per Day). | Rain-fall collected (Inches). | Percent-age of Rain-fall collected. |
|----------------|---|--|---|--|---|---|-------------------------|-------------------------|---|-------------------------------|-------------------------------------|
| | | | | | | | Gain (Gallons per Day). | Loss (Gallons per Day). | | | |
| January, | 83,539,000 | 96,016,000 | 29,145,000 | 603,000 | 1,003,000 | 74,052,000 | - | - | 112,019,000 | 5.39 | 2.657 |
| February, | 81,982,000 | 92,586,000 | 28,986,000 | 589,000 | 1,461,000 | 78,357,000 | 19,039,000 | - | 139,036,000 | 5.06 | 2.979 |
| March, | 77,065,000 | 83,865,000 | 28,706,000 | 545,000 | 1,587,000 | 118,929,000 | - | 9,626,000 | 146,042,000 | 0.85 | 3.486 |
| April, | 107,240,000 | 80,253,000 | 29,127,000 | 540,000 | 903,000 | 36,710,000 | 9,840,000 | - | 50,133,000 | 2.75 | 1.151 |
| May, | 93,587,000 | 79,790,000 | 29,274,000 | 545,000 | 787,000 | 9,116,000 | - | 5,071,000 | 20,835,000 | 1.29 | 0.495 |
| June, | 100,400,000 | 81,357,000 | 28,833,000 | 603,000 | 760,000 | 31,667,000 | - | 3,993,000 | 38,827,000 | 4.68 | 0.891 |
| July, | 131,732,000 | 92,906,000 | 29,355,000 | 748,000 | 484,000 | 1,958,000 | - | 1,410,000 | -7,690,000 | 2.03 | -0.182 |
| August, | 121,455,000 | 87,845,000 | 29,449,000 | 606,000 | 468,000 | 1,500,000 | - | 3,848,000 | -5,468,000 | 2.02 | -0.130 |
| September, | 111,333,000 | 82,293,000 | 28,330,000 | 607,000 | 497,000 | 1,500,000 | - | 1,523,000 | 370,000 | 2.49 | 0.008 |
| October, | 110,281,000 | 79,219,000 | 28,726,000 | 665,000 | 413,000 | 1,500,000 | - | 4,055,000 | -3,813,000 | 1.86 | -0.091 |
| November, | 97,670,000 | 71,250,000 | 28,710,000 | 670,000 | 580,000 | 9,573,000 | 143,000 | - | 13,257,000 | 4.13 | 0.304 |
| December, | 119,542,000 | 92,942,000 | 29,032,000 | 790,000 | 697,000 | 11,558,000 | 1,145,000 | - | 16,642,000 | 2.49 | 0.395 |
| Total, | - | - | - | - | - | - | - | - | - | 35.64 | 11.963 |
| A.v. for year, | 103,145,000 | 85,033,000 | 28,974,000 | 627,000 | 799,000 | 31,108,000 | - | 561,000 | 42,835,000 | - | 33.6 |

¹ Not including 137,000 gallons per day drawn through Wachusett Aqueduct for the supply of the Westborough Insane Hospital, which were not discharged into Sudbury Reservoir.

TABLE No. 11.—Cochituate System.—Statistics of Flow of Water, Storage and Rainfall in 1910.

(Watershed of lake = 17.80 square miles.)

| MONTH. | Quantity of Water discharged through Cochituate Aqueduct (Gallons per Day). | Quantity of Water diverted from Watershed by Sewers, etc. (Gallons per Day). | Quantity of Water wasted at Outlet of Lake (Gallons per Day). | STORAGE. | | Total Yield of Watershed (Gallons per Day). | Rainfall collected (Inches). | Percent-age of Rainfall collected. |
|---------------------|---|--|---|-------------------------|-------------------------|---|------------------------------|------------------------------------|
| | | | | Gain (Gallons per Day). | Loss (Gallons per Day). | | | |
| January, | - | 958,000 | - | 26,926,000 | - | 27,884,000 | 5.11 | 2.80 |
| February, | - | 1,157,000 | 23,929,000 | 7,204,000 | - | 32,289,000 | 5.16 | 2.92 |
| March, | - | 516,000 | 31,716,000 | - | 4,487,000 | 27,745,000 | 0.77 | 2.78 |
| April, | - | 653,000 | 27,297,000 | - | 14,757,000 | 13,193,000 | 2.71 | 1.28 |
| May, | - | 429,000 | 6,226,000 | 281,000 | - | 6,935,000 | 1.33 | 0.70 |
| June, | - | 430,000 | 19,380,000 | - | 8,230,000 | 11,780,000 | 4.51 | 1.14 |
| July, | - | 68,000 | 4,539,000 | - | 1,713,000 | 2,894,000 | 2.23 | 0.29 |
| August, | - | 155,000 | - | - | - | 1,160,000 | 1.58 | 0.02 |
| September, | - | 140,000 | - | - | 1,020,000 | - | 2.50 | 0.11 |
| October, | - | 74,000 | - | - | 329,000 | 403,000 | 1.80 | 0.04 |
| November, | - | 133,000 | - | - | 4,223,000 | - | 4,357,000 | 4.16 |
| December, | - | 297,000 | - | - | 5,529,000 | - | 5,826,000 | 2.61 |
| Total, | - | - | - | - | - | - | 34.47 | 13.08 |
| Average for year, . | 412,000 | 9,296,000 | 1,376,000 | - | - | 11,065,000 | - | 37.9 |

¹ Not including the watersheds of Dudley and Dug ponds.

TABLE No. 12.—Elevations of Water Surfaces of Reservoirs above Boston City Base at the Beginning of Each Month.

| DATE. | Chestnut Hill Reservoir. | Lake Cochituate. | Farm Pond. | Spot Pond. | Weston Reservoir. High Water =163.00. =200.00. | FRAMINGHAM RESERVOIR. | | | Ashland Reservoir. Flash Boards 225.23. | Sudbury Reservoir. Flash Boards 259.97. | Hopkinton Reservoir. Flash Boards 305.00. | Whitehall Reservoir. Ordinary High Water =337.91. | Wachusett Reservoir. Ordinary High Water =395.00. |
|------------------|--------------------------------|---------------------|---------------|---------------|--|-----------------------|--------|--------|---|---|---|---|---|
| | No. 1. | No. 2. | No. 3. | | | | | | | | | | |
| Jan. 1, 1910, * | 133.42 | 138.76 | 157.58 | 162.86 | 200.00 | 167.65 | 175.99 | 182.41 | 224.35 | 259.28 | 304.12 | 337.24 | 382.09 |
| Feb. 1, 1910, * | 134.03 | 142.69 | 158.21 | 163.22 | 200.08 | 168.05 | 176.34 | 183.54 | 224.11 | 259.19 | 302.97 | 336.22 | 385.14 |
| Mar. 1, 1910, * | 134.11 | 143.54 | 158.71 | 162.80 | 200.12 | 168.60 | 176.85 | 186.56 | 223.93 | 259.52 | 304.00 | 336.36 | 386.20 |
| April 1, 1910, * | 133.98 | 142.96 | 158.51 | 163.02 | 200.00 | 167.92 | 176.15 | 185.50 | 224.44 | 259.27 | 304.17 | 335.96 | 393.72 |
| May 1, 1910, * | 133.82 | 140.97 | 158.31 | 162.98 | 199.98 | 167.82 | 176.13 | 184.84 | 224.46 | 260.02 | 304.25 | 336.19 | 393.99 |
| June 1, 1910, * | 133.71 | 141.01 | 158.01 | 162.89 | 200.08 | 169.41 | 177.18 | 184.19 | 225.35 | 259.25 | 304.85 | 336.34 | 393.48 |
| July 1, 1910, * | 133.57 | 139.84 | 157.99 | 162.75 | 200.00 | 165.46 | 177.09 | 184.00 | 225.27 | 259.25 | 305.03 | 336.64 | 393.39 |
| Aug. 1, 1910, * | 134.38 | 139.58 | 157.63 | 162.57 | 200.02 | 166.75 | 176.50 | 184.24 | 225.10 | 259.31 | 304.61 | 336.35 | 390.64 |
| Sept. 1, 1910, * | 133.91 | 139.58 | 157.31 | 162.82 | 200.00 | 167.12 | 176.56 | 184.00 | 225.09 | 259.22 | 304.12 | 336.18 | 388.26 |
| Oct. 1, 1910, * | 133.84 | 139.73 | 157.22 | 162.81 | 199.97 | 167.60 | 177.00 | 182.94 | 225.05 | 259.24 | 304.05 | 336.19 | 386.05 |
| Nov. 1, 1910, * | 134.01 | 139.78 | 157.05 | 162.14 | 199.91 | 167.46 | 176.94 | 182.26 | 224.89 | 259.20 | 303.93 | 336.07 | 383.36 |
| Dec. 1, 1910, * | 133.95 | 140.39 | 157.25 | 161.37 | 200.05 | 167.68 | 175.99 | 182.76 | 224.40 | 259.22 | 304.11 | 336.04 | 381.66 |
| Jan. 1, 1911, * | 133.70 | 141.19 | 157.42 | 162.66 | 200.07 | 167.74 | 176.06 | 183.64 | 224.40 | 259.25 | 304.16 | 335.70 | 379.35 |

TABLE NO. 13.—*Sources from which and Periods during which Water has been drawn for the Supply of the Metropolitan Water District.*

From Wachusett Reservoir into Sudbury Reservoir.

| |
|--|
| 7:00 A.M. Jan. 1, 1910 to 10:15 A.M. Jan. 7, 1910. |
| 7:00 A.M. Jan. 8, 1910 " 9:30 A.M. Jan. 22, 1910. |
| 7:05 A.M. Jan. 26, 1910 " 11:00 A.M. Jan. 26, 1910. |
| 10:00 P.M. Jan. 26, 1910 " 10:10 A.M. Feb. 17, 1910. |
| 11:10 A.M. Feb. 18, 1910 " 11:00 A.M. Feb. 21, 1910. |
| 1:00 P.M. Feb. 24, 1910 " 10:00 A.M. Feb. 28, 1910. |
| 2:00 P.M. Mar. 10, 1910 " 9:30 A.M. Apr. 13, 1910. |
| 10:00 A.M. Apr. 14, 1910 " 7:15 A.M. Apr. 26, 1910. |
| 3:00 P.M. Apr. 26, 1910 " 10:30 A.M. June 10, 1910. |
| 12:00 N. June 11, 1910 " 10:30 A.M. July 12, 1910. |
| 5:30 P.M. July 12, 1910 " 10:00 A.M. July 13, 1910. |
| 3:00 P.M. July 13, 1910 " 6:00 A.M. July 23, 1910. |
| 1:10 P.M. July 23, 1910 " 11:45 A.M. July 25, 1910. |
| 5:10 P.M. July 25, 1910 " 6:00 A.M. July 26, 1910. |
| 2:00 P.M. July 26, 1910 " 10:00 P.M. Dec. 4, 1910. |
| 5:00 P.M. Dec. 5, 1910 " 10:00 P.M. Dec. 26, 1910. |
| 5:00 P.M. Dec. 27, 1910 " 7:00 A.M. Jan. 1, 1911. |

Total quantity, 37,698,200,000 gallons.

From Sudbury Reservoir through the Weston Aqueduct to the Weston Reservoir.

7:00 A.M. Jan. 1, 1910 to 7:00 A.M. Jan. 1, 1911.

Total quantity, 10,575,600,000 gallons.

From Framingham Reservoir No. 3 through Sudbury Aqueduct to Chestnut Hill Reservoir.

7:00 A.M. Jan. 1, 1910 to 7:00 A.M. Jan. 1, 1911.

Total quantity, 31,037,100,000 gallons.

TABLE No. 14.—*Average Daily Quantity of Water flowing through Aqueducts in 1910 by Months.*¹

| MONTH. | Wachusett Aqueduct into Sudbury Reservoir (Gallons). | Weston Aqueduct into Metropolitan District (Gallons). | Sudbury Aqueduct into Chester Hill Reservoir (Gallons). |
|------------------------------|---|--|--|
| January, | 83,539,000 | 29,145,000 | 96,016,000 |
| February, | 81,982,000 | 28,986,000 | 92,586,000 |
| March, | 77,065,000 | 28,706,000 | 83,865,000 |
| April, | 107,240,000 | 29,127,000 | 80,253,000 |
| May, | 93,587,000 | 29,274,000 | 79,790,000 |
| June, | 100,400,000 | 28,833,000 | 81,357,000 |
| July, | 131,732,000 | 29,355,000 | 92,906,000 |
| August, | 121,458,000 | 29,419,000 | 87,845,000 |
| September, | 111,333,000 | 28,330,000 | 82,293,000 |
| October, | 110,281,000 | 28,726,000 | 79,219,000 |
| November, | 97,670,000 | 28,710,000 | 71,250,000 |
| December, | 119,542,000 | 29,052,000 | 92,942,000 |
| Average, | 103,145,000 | 28,974,000 | 85,033,000 |

¹ Not including quantities wasted while cleaning and repairing aqueducts.

TABLE No. 15.—Statement of Operation of Engines Nos. 1 and 2 at Chestnut Hill High-service Pumping Station for the Year 1910.

[3 per cent. allowed for slip.]

| MONTH. | ENGINE No. 1. | | ENGINE No. 2. | | AVERAGE Lift (FEEt). |
|------------|-----------------------|---|-----------------------|---|-------------------------|
| | Total Pumped Time. | Amount of Pumped Water, in Corrected for Slip (Million Gallons). | Total Pumped Time. | Amount of Pumped Water, in Corrected for Slip (Million Gallons). | |
| January, | 214 10 | 70.23 | 216 00 | 69.81 | 140.04 |
| February, | 235 35 | 83.63 | 117 35 | 40.18 | 243,042 |
| March, | 33 45 | 12.51 | 190 25 | 65.30 | 207,654 |
| April, | 151 15 | 53.94 | 173 45 | 61.08 | 24,118 |
| May, | 158 30 | 56.73 | 103 50 | 36.15 | 154,600 |
| June, | 301 45 | 110.75 | — | — | 24,887 |
| July, | 515 35 | 181.31 | — | — | 169,697 |
| August, | 359 25 | 122.76 | — | — | 25,630 |
| September, | 279 20 | 92.98 | — | — | 173,178 |
| October, | 142 50 | 48.28 | 110 50 | 36.90 | 237,178 |
| November, | 265 57 | 92.38 | 87 00 | 29.32 | 26,052 |
| December, | — | — | 337 00 | 113.47 | 122.76 |
| Total, | 2,658 07 | 925.50 | 1,336 25 | 452.21 | 185,480 |
| Average, | — | — | — | — | 18,840 |
| | | | | | 10.2 |
| | | | | | 661.85 |
| | | | | | 11.1 |
| | | | | | 609.16 |
| | | | | | 15.625 |
| | | | | | 150,175 |
| | | | | | 85.18 |
| | | | | | 92.98 |
| | | | | | 152,637 |
| | | | | | 121.70 |
| | | | | | 113.47 |
| | | | | | 199,802 |
| | | | | | 1,377.71 |
| | | | | | 2,168,024 |
| | | | | | 260,254 |
| | | | | | — |
| | | | | | — |
| | | | | | 12.0 |
| | | | | | 635.47 |
| | | | | | 119.41 |
| | | | | | 120.19 |
| | | | | | 63,340,000 |
| | | | | | 65,310,000 |

Duty in Foot-pounds of Coal,
per 100 Pounds of Fuel,
Basis of Plunderer's
Duties for Heating or
Lighting.

Duty in Foot-pounds of Coal,
per 100 Pounds of Fuel,
Basis of Plunderer's Duties
for Heating or Lighting or
Corrected for Slippage.

Duty in Foot-pounds of Coal,
per 100 Pounds of Fuel,
Basis of Plunderer's Duties
for Heating or Lighting or
Corrected for Slippage.

Duty in Foot-pounds of Coal,
per 100 Pounds of Fuel,
Basis of Plunderer's Duties
for Heating or Lighting or
Corrected for Slippage.

Duty in Foot-pounds of Coal,
per 100 Pounds of Fuel,
Basis of Plunderer's Duties
for Heating or Lighting or
Corrected for Slippage.

Duty in Foot-pounds of Coal,
per 100 Pounds of Fuel,
Basis of Plunderer's Duties
for Heating or Lighting or
Corrected for Slippage.

TABLE No. 16.—Statement of Operation of Engine No. 3 at Chestnut Hill High-service Pumping Station for the Year 1910.

[4.4 per cent. allowed for slip.]

| MONTH. | Total Pumping Time. | | Amount Pumped, corrected for Slip (Million Gallons). | Amount of Ashes and Clinkers (Pounds). | Per Cent. of Ashes and Clinkers. | Quantity pumped per Pound of Coal, no Deduction for Heating or Lighting (Gallons). | Average Lift (Feet). | Duty in Foot-pounds per 100 Pounds of Coal, on Basis of Pumping Duty in Foot-pounds of Coal, per 100 Pounds of Coal, Displacement, no Deduction for Heating or Lighting. |
|------------|---------------------|------|--|--|----------------------------------|--|----------------------|--|
| | Hrs. | Min. | | | | | | |
| January, | - | - | - | - | - | - | - | - |
| February, | - | - | - | - | - | - | - | - |
| March, | - | - | - | - | - | - | - | - |
| April, | 95 | 45 | 81.46 | 36,956 | 10,437 | 12.1 | 936.80 | 129.05 |
| May, | - | - | - | - | - | - | - | - |
| June, | - | - | - | - | - | - | - | - |
| July, | - | - | - | - | - | - | - | - |
| August, | - | - | - | - | - | - | - | - |
| September, | - | - | - | - | - | - | - | - |
| October, | - | - | - | - | - | - | - | - |
| November, | - | - | - | - | - | - | - | - |
| December, | - | - | - | - | - | - | - | - |
| Total, | 268 | 50 | 228.67 | 247,119 | 27,084 | - | 11.0 | 925.34 |
| Average, | - | - | - | - | - | - | 129.88 | 100,110,000 |

TABLE NO. 17.—Statement of Operation of Engine No. 4 at Chestnut Hill High-service Pumping Station for the Year 1910.

[2 per cent. allowed for slip.]

| Month. | Total Pumping Time. | Amount of Coal pumped, corrected for Slip (Million Gallons). | Amount of Ashes and Cinders (Pounds). | Per Cent. of Ashes and Cinders. | Quantity Pumped per 100 Pounds of Coal, on Basis of Coal, no Deduction for Heating or Duties. | Duty in Foot-Pounds per 100 Pounds of Coal, per 100 Pounds of Coal, no Deduction for Heating or Duties. | Average Lift (Feet). | Duty in Foot-Pounds per 100 Pounds of Coal, per 100 Pounds of Coal, no Deduction for Heating or Duties. | Base of Pumper, no Deduction for Heating or Duties. | Dishonesty of Pumper, no Deduction for Heating or Duties. | Duty in Foot-Pounds per 100 Pounds of Coal, per 100 Pounds of Coal, no Deduction for Heating or Duties. | Base of Pumper, no Deduction for Heating or Duties. | Dishonesty of Pumper, no Deduction for Heating or Duties. | Total Amount Pumped (Million Gallons). | (Million Gallons). | Daily Average Pumped (Million Gallons). | Summary of Engines Nos. 1, 2, 3 and 4. |
|-----------------------|---------------------|--|---------------------------------------|---------------------------------|---|---|----------------------|---|---|---|---|---|---|--|--------------------|---|--|
| | | | | | | | | | | | | | | | | | |
| January, | - | 949.65 | 752,493 | 79,325 | 10.5 | 1,262.01 | 130.06 | 136,730,000 | 139,480,000 | 1,089.69 | 35.151 | | | | | | |
| February, | - | 858.05 | 661,802 | 62,363 | 9.4 | 1,296.54 | 131.06 | 141,550,000 | 144,400,000 | 981.86 | 35.067 | | | | | | |
| March, | - | 945.15 | 755,165 | 92,527 | 12.3 | 1,251.58 | 131.57 | 137,170,000 | 139,930,000 | 1,022.96 | 32.999 | | | | | | |
| April, | - | 793.77 | 641,073 | 80,725 | 12.6 | 1,237.03 | 130.05 | 134,010,000 | 136,760,000 | 990.25 | 33.008 | | | | | | |
| May, | - | 947.00 | 757,388 | 83,465 | 11.0 | 1,250.35 | 130.34 | 135,750,000 | 138,480,000 | 1,039.88 | 33.544 | | | | | | |
| June, | - | 921.21 | 741,409 | 87,960 | 11.9 | 1,242.51 | 130.53 | 135,100,000 | 137,820,000 | 1,031.96 | 34.399 | | | | | | |
| July, | - | 954.95 | 749,361 | 80,204 | 10.7 | 1,274.35 | 131.17 | 139,240,000 | 142,040,000 | 1,136.26 | 36.654 | | | | | | |
| August, | - | 951.44 | 731,995 | 73,630 | 10.1 | 1,299.79 | 130.98 | 141,820,000 | 144,670,000 | 1,074.20 | 34.632 | | | | | | |
| September, | - | 920.32 | 697,868 | 68,400 | 9.8 | 1,318.76 | 129.81 | 142,600,000 | 145,470,000 | 1,013.30 | 33.777 | | | | | | |
| October, ¹ | - | 951.58 | 720,695 | 71,405 | 9.9 | 1,320.36 | 130.77 | 143,830,000 | 146,720,000 | 1,036.76 | 33.444 | | | | | | |
| November, | - | 683.55 | 521,295 | 50,991 | 9.8 | 1,311.25 | 129.96 | 141,950,000 | 144,800,000 | 952.46 | 31.749 | | | | | | |
| December, | - | 948.03 | 736,733 | 80,220 | 10.9 | 1,286.80 | 130.43 | 139,810,000 | 142,620,000 | 1,061.50 | 34.242 | | | | | | |
| Total, | - | 10,824.70 | 8,467,877 | 911,215 | - | 10.8 | 1,278.33 | 130.58 | - | - | 12,431.08 | - | | | | | 34.058 |
| Average, | - | - | - | - | - | - | - | - | - | - | - | - | | | | | |

TABLE No. 18.—Statement of Operation of Engines Nos. 5, 6 and 7; at Chestnut Hill Low-service Pumping Station for the Year 1910.

[2 per cent. allowed for slip.]

| MONTH. | Engine No. 5. | ENGINE NO. 6. | ENGINE NO. 7. | Total Pumping Time. | Amount pumped, cor-rected for Slip (Mil-lion Gallons). | Total Amount pumped (Mil-lion Gallons). | Daily Average Amount pumped (Mil-lion Gallons). | Total Amount of Coal con-sumed (Pounds). | Quantity pumped per Pound of Coal, no Deduction for Heating or Lighting (Gallons). | Quantity pumped per Pound of Coal, no Deduction for Heating or Lighting (Gallons). | Duty in Foot-Pounds per 100 Pounds of Coal Delivered for Heating or Lighting; or Slip. | Basis of Payment for Coal Delivered for Heating or Lighting. | Duty in Foot-Pounds per 100 Pounds of Coal Delivered for Heating or Lighting. | | |
|------------|---------------|---------------|---------------|---------------------|--|---|---|--|--|--|--|--|---|-------------|-------------|
| | | | | Hrs. Min. | | | | | Average Lift (Feet). | | | | | | |
| January, | - | 698 15 | 768.47 | 726 15 | 800.19 | 232 55 | 312.04 | 1,880.70 | 60.668 | 692,495 | 10.3 | 2,715.83 | 49.61 | 49.76 | 35.31 |
| February, | - | 552 05 | 594.06 | 644 25 | 717.90 | 260 20 | 310.71 | 1,622.67 | 57.953 | 586,485 | 9.9 | 2,766.77 | 49.55 | 48.84 | 28.65 |
| March, | - | 479 30 | 524.50 | 616 55 | 711.89 | 326 10 | 346.07 | 1,582.46 | 51.047 | 585,570 | 10.4 | 2,702.43 | 50.35 | 49.44 | 25.25 |
| April, | - | 374 55 | 461.08 | 495 50 | 598.20 | 341 55 | 337.97 | 1,397.25 | 46.575 | 493,350 | 10.0 | 2,832.17 | 49.49 | 47.01 | 24.75 |
| May, | - | 500 40 | 578.46 | 550 10 | 595.84 | 256 05 | 254.01 | 1,428.31 | 46.075 | 578,230 | 10.0 | 2,470.14 | 56.64 | 57.45 | 29.46 |
| June, | - | 436 40 | 488.06 | 500 15 | 589.91 | 292 05 | 313.57 | 1,391.54 | 46.385 | 546,425 | 12.4 | 2,546.63 | 53.49 | 51.89 | 40.01 |
| July, | - | 589 05 | 632.01 | 737 30 | 812.37 | 170 40 | 185.79 | 1,650.17 | 53.231 | 671,380 | 12.1 | 2,457.88 | 56.64 | 56.79 | 52.68 |
| August, | - | 661 35 | 682.55 | 702 00 | 728.00 | 179 45 | 207.14 | 1,617.69 | 52.184 | 652,855 | 12.4 | 2,477.87 | 55.70 | 55.83 | 28.16 |
| September, | - | 550 20 | 623.62 | 566 05 | 651.21 | 143 45 | 147.35 | 1,422.18 | 47.406 | 542,220 | 10.5 | 2,622.88 | 51.60 | 51.30 | 21.36 |
| October, | - | 586 35 | 676.01 | 293 00 | 351.63 | 370 20 | 343.75 | 1,371.39 | 44.238 | 525,320 | 8.3 | 2,610.58 | 56.55 | 53.21 | 19.41 |
| November, | - | 30 40 | 29.93 | 720 00 | 810.34 | 439 10 | 363.42 | 1,293.69 | 40.123 | 500,845 | 8.9 | 2,403.32 | 61.43 | 61.57 | 19.06 |
| December, | - | 723 40 | 804.83 | 728 00 | 811.72 | 169 15 | 209.92 | 1,828.47 | 58.918 | 747,215 | 10.9 | 2,444.37 | 58.02 | 57.95 | 23.72 |
| Total, | - | 6,184 00 | 6,883.58 | 7,280 25 | 8,179.20 | 3,182 25 | 3,331.74 | 18,394.52 | - | 7,122,390 | - | - | - | - | - |
| Average, | - | - | - | - | - | - | - | - | - | 50,396 | - | 10.6 | 2,582.65 | 53.66 | 28.33 |
| | | | | | | | | | | | | | 105,590,000 | 105,590,000 | 107,750,000 |

TABLE No. 19.—Statement of Operation of Engine No. 8 at Spot Pond Pumping Station for the Year 1910.

[2 per cent. allowed for slip.]

| MONTH. | Total Pumping Time. | Amount Pumped, corrected for Slip (Million Gallons). | Amount of Coal consumed (Pounds). | Clinkers, Amount of Ashes and Clinkers. | Per Cent. of Ashes and Clinkers. | Quantity Pumped per Ton of Coal, no Deduction for Heating or Lighting (Gallons). | Duty in Foot-pounds per 100 Pounds of Coal, no Deduction for Heating or Lighting; corrected for Slip. | Duty in Foot-pounds per 100 Pounds of Coal, no Deduction for Heating or Lighting or Weight; no Deduction for Slippage; no Deduction for Heating or Lighting or Weight. | Average Lift (Fleet). | Duty in Foot-pounds per 100 Pounds of Coal, no Deduction for Heating or Lighting or Weight. | |
|------------|---------------------|--|-----------------------------------|---|----------------------------------|--|---|--|-----------------------|---|-------------|
| | | | | | | | | | | | |
| January, | 13 00 | 5,651 | 965 | 17.1 | 990.98 | 119.36 | - | 98,550,000 | 100,550,000 | - | - |
| February, | - - - | - - - | - - - | - - - | - - - | - - - | - - - | - | - | - | - |
| March, | 14 00 | 6,112 | 6,186 | 1,034 | 16.7 | 989.33 | 121.89 | 100,450,000 | 102,520,000 | - | - |
| April, | 14 00 | 6.11 | 6,100 | 1,120 | 18.4 | 1,001.64 | 121.03 | 100,980,000 | 103,000,000 | - | - |
| May, | - - - | - - - | - - - | - - - | - - - | - - - | - - - | - | - | - | - |
| June, | 29 00 | 12,20 | 12,317 | 2,206 | 17.9 | 990.50 | 124.83 | 103,000,000 | 105,120,000 | - | - |
| July, | - - - | - - - | - - - | - - - | - - - | - - - | - - - | - | - | - | - |
| August, | 15 30 | 7.02 | 6,840 | 975 | 14.3 | 1,026.32 | 120.60 | 103,100,000 | 105,220,000 | - | - |
| September, | - - - | - - - | - - - | - - - | - - - | - - - | - - - | - | - | - | - |
| October, | 63 45 | 27.70 | 28,036 | 2,110 | 7.5 | 988.02 | 119.73 | 98,540,000 | 100,600,000 | - | - |
| November, | 12 00 | 5.38 | 6,330 | 935 | 14.8 | 849.92 | 121.94 | 86,330,000 | 88,110,000 | - | - |
| December, | - - - | - - - | - - - | - - - | - - - | - - - | - - - | - | - | - | - |
| Total, | 161 15 | 70.13 | 71,460 | 9,345 | - | - | 13.1 | 981.30 | 121.15 | 99,040,000 | 101,080,000 |
| Average, | - - - | - - - | - - - | - - - | - - - | - - - | - - - | - | - | - | - |

TABLE No. 20.—Statement of Operation of Engine No. 9 at Spot Pond Pumping Station for the Year 1910.

[2 per cent. allowed for slip.]

TABLE No. 21.—(*Meter Basis.*) *Average Daily Consumption of Water during the Year 1910, in the Cities and Towns supplied by the Metropolitan Water Works, including Boston, Somerville, Chelsea, Malden, Everett, Quincy, Medford, Melrose, Revere, Watertown, Arlington, Lexington, Milton, Stoneham, Winthrop, Swampscott, Belmont and Nahant. (For Consumption of Water in Whole Metropolitan Water District, see Table No. 24.)*

| MONTH. | Average Daily Consumption (Gallons). | Estimated Population. | Consumption per Inhabitant (Gallons). |
|-------------------------|--------------------------------------|-----------------------|---------------------------------------|
| January, | 123,249,800 | 1,008,340 | 122 |
| February, | 123,890,200 | 1,010,350 | 123 |
| March, | 111,156,600 | 1,012,400 | 110 |
| April, | 106,842,500 | 1,014,610 | 105 |
| May, | 107,454,700 | 1,017,510 | 106 |
| June, | 109,031,100 | 1,020,330 | 107 |
| July, | 116,950,000 | 1,027,350 | 114 |
| August, | 111,973,800 | 1,028,120 | 109 |
| September, | 107,788,600 | 1,027,940 | 105 |
| October, | 106,881,000 | 1,027,500 | 104 |
| November, | 103,343,800 | 1,028,880 | 100 |
| December, | 117,015,000 | 1,030,960 | 114 |
| For the year, | 112,092,100 | 1,022,230 | 110 |

In addition to the above quantities, the United States Government Reservation on Peddocks Island was supplied with 31,191,300 gallons, equivalent to a daily average rate of 85,400 gallons, and a part of Saugus with 6,003,000 gallons, equivalent to a daily average rate of 16,500 gallons.

TABLE No. 22.—(*Meter Basis.*) *Average Daily Consumption of Water in Gallons, from the Low-service System in 1910.*

| MONTH. | SOUTHERN LOW SERVICE. | NORTHERN LOW SERVICE. | Total Low-service Consumption. |
|-------------------------|--|--|--------------------------------|
| | Boston, excluding East Boston and Charlestown. | Portions of Charlestown, Somerville, Chelsea, Everett, Malden, Medford, East Boston and Arlington. | |
| January, | 52,008,400 | 29,341,300 | 81,349,700 |
| February, | 52,117,200 | 29,847,800 | 81,965,000 |
| March, | 45,794,400 | 25,807,200 | 71,601,600 |
| April, | 43,047,100 | 24,374,300 | 67,421,400 |
| May, | 41,733,600 | 25,083,900 | 66,817,500 |
| June, | 41,526,700 | 25,628,700 | 67,155,400 |
| July, | 43,641,900 | 27,356,100 | 70,998,000 |
| August, | 42,837,100 | 25,988,400 | 68,825,500 |
| September, | 41,869,400 | 24,635,000 | 66,504,400 |
| October, | 41,724,200 | 24,242,100 | 65,966,300 |
| November, | 41,642,300 | 23,258,700 | 64,901,000 |
| December, | 48,406,200 | 27,016,300 | 75,422,500 |
| For the year, | 44,667,600 | 26,032,400 | 70,700,000 |

TABLE No. 23.—(*Meter Basis.*) *Average Daily Consumption of Water, in Gallons, from the High-service and Extra High-service Systems in 1910.*

| MONTH. | SOUTHERN HIGH SERVICE. | SOUTHERN EXTRA HIGH SERVICE. | NORTHERN HIGH SERVICE. | NORTHERN EXTRA HIGH SERVICE. |
|-------------------------|---|--------------------------------------|--|---|
| | Quincy, Watertown, and Portions of Boston, Belmont and Milton. | Portions of Boston and Milton. | Revere, Winthrop, Swampscott, Nahant, Stone- ham, Melrose, and Portions of Boston, Chelsea, Everett, Malden, Medford and Somerville. | Lexington and Portions of Arlington and Belmont. |
| January, | 33,789,700 | 567,800 | 6,930,700 | 611,900 |
| February, | 33,602,900 | 612,500 | 7,057,100 | 652,700 |
| March, | 31,694,600 | 614,600 | 6,631,700 | 614,100 |
| April, | 31,378,500 | 623,800 | 6,716,500 | 702,300 |
| May, | 32,169,800 | 682,300 | 7,013,800 | 771,300 |
| June, | 32,816,400 | 709,000 | 7,587,300 | 763,000 |
| July, | 34,946,300 | 856,700 | 9,023,100 | 1,125,900 |
| August, | 32,922,500 | 794,100 | 8,476,000 | 955,700 |
| September, | 32,402,700 | 708,800 | 7,346,900 | 825,800 |
| October, | 32,276,200 | 705,100 | 7,124,500 | 808,900 |
| November, | 30,406,600 | 651,100 | 6,679,000 | 706,100 |
| December, | 33,330,900 | 640,100 | 6,883,400 | 738,100 |
| For the year, | 32,644,400 ¹ | 681,000 | 7,292,600 ² | 774,100 |

In addition to the above ¹ the United States Government Reservation on Peddocks Island was supplied with a daily average rate of 85,400 gallons, and ² part of Saugus with a daily average rate of 16,500 gallons.

TABLE No. 24.—*Average Daily Consumption of Water in Cities and Towns supplied from Metropolitan Works, as measured by Venuri Meters in 1910.*

| Month. | Population supplied, | BOSTON. | | SOMERVILLE. | | MALDEN. | | CHELSEA. | | EVERETT. | | QUINCY. | | MEDFORD. | |
|---------------|----------------------|------------|-------------|-------------|-------------|-----------|-------------|-----------|-------------|-----------|-------------|-----------|-------------|-----------|-------------|
| | | 674,400. | | 77,640. | | 44,730. | | 32,540. | | 33,710. | | 32,870. | | 23,330. | |
| | | GALLONS. | GALLONS. | GALLONS. | GALLONS. | GALLONS. | GALLONS. | GALLONS. | GALLONS. | GALLONS. | GALLONS. | GALLONS. | GALLONS. | GALLONS. | GALLONS. |
| Per Day. | Per Capita. | Per Day. | Per Capita. | Per Day. | Per Capita. | Per Day. | Per Capita. | Per Day. | Per Capita. | Per Day. | Per Capita. | Per Day. | Per Capita. | Per Day. | Per Capita. |
| January, | * | 98,972,100 | 148 | 6,497,200 | 85 | 1,808,600 | 41 | 3,013,700 | 93 | 2,898,000 | 87 | 2,458,900 | 76 | 1,570,400 | 68 |
| February, | * | 99,226,600 | 149 | 6,451,100 | 84 | 1,823,000 | 41 | 3,113,000 | 96 | 2,942,700 | 88 | 2,440,300 | 75 | 1,583,700 | 69 |
| March, | * | 88,220,600 | 132 | 5,906,300 | 77 | 1,787,000 | 40 | 2,803,800 | 86 | 2,469,400 | 74 | 2,455,300 | 75 | 1,431,400 | 62 |
| April, | * | 84,165,200 | 126 | 5,734,600 | 74 | 1,750,800 | 39 | 2,619,900 | 81 | 2,405,600 | 72 | 2,501,000 | 77 | 1,366,900 | 59 |
| May, | * | 83,516,100 | 124 | 6,152,500 | 80 | 1,763,600 | 40 | 2,647,100 | 81 | 2,406,200 | 72 | 2,729,500 | 83 | 1,437,100 | 62 |
| June, | * | 84,070,500 | 125 | 6,202,300 | 80 | 1,901,400 | 43 | 2,726,900 | 84 | 2,515,000 | 75 | 2,979,500 | 91 | 1,422,400 | 61 |
| July, | * | 87,050,000 | 130 | 6,504,500 | 84 | 2,168,300 | 48 | 2,896,800 | 89 | 2,692,200 | 80 | 3,665,900 | 112 | 1,809,600 | 81 |
| August, | * | 84,596,800 | 125 | 6,211,500 | 80 | 2,133,800 | 48 | 2,888,900 | 89 | 2,535,200 | 77 | 3,521,000 | 107 | 1,542,100 | 66 |
| September, | * | 82,918,900 | 123 | 6,081,000 | 78 | 1,909,600 | 42 | 2,920,500 | 90 | 2,479,100 | 73 | 3,135,500 | 95 | 1,255,100 | 54 |
| October, | * | 82,298,800 | 121 | 6,256,400 | 80 | 1,894,000 | 42 | 2,775,200 | 85 | 2,473,000 | 73 | 3,055,500 | 92 | 1,257,100 | 53 |
| November, | * | 80,297,800 | 118 | 5,933,600 | 76 | 1,755,100 | 39 | 2,717,300 | 83 | 2,323,700 | 68 | 2,878,400 | 87 | 1,150,000 | 49 |
| December, | * | 92,777,700 | 136 | 6,355,300 | 81 | 1,786,900 | 39 | 2,907,200 | 89 | 2,733,900 | 80 | 2,843,200 | 85 | 1,155,000 | 49 |
| For the year, | * | 87,346,700 | 130 | 6,189,500 | 80 | 1,874,400 | 42 | 2,834,500 | 87 | 2,575,600 | 76 | 2,891,900 | 88 | 1,422,400 | 61 |

TABLE No. 24.—*Average Daily Consumption of Water in Cities and Towns, etc.*—Continued.

| City or town, | Population supplied, | MELROSE. | | REVERE. | | WATERTOWN. | | ARLINGTON. | | MILTON. | | WINTHROP. | |
|---------------|----------------------|----------|-------------|----------|-------------|------------|-------------|------------|-------------|-----------|-------------|-----------|-------------|
| | | 15,790. | | 18,500. | | 12,960. | | 11,270. | | 7,970. | | 10,290. | |
| | | GALLONS. | | GALLONS. | | GALLONS. | | GALLONS. | | GALLONS. | | GALLONS. | |
| MONTH. | | Per Day. | Per Capita. | Per Day. | Per Capita. | Per Day. | Per Capita. | Per Day. | Per Capita. | Per Day. | Per Capita. | Per Day. | Per Capita. |
| January, | • | • | • | • | • | 897,000 | 57 | 1,260,600 | 70 | 763,600 | 60 | 798,500 | 72 |
| February, | • | • | • | • | • | 929,100 | 59 | 1,307,100 | 72 | 780,600 | 61 | 809,500 | 73 |
| March, | • | • | • | • | • | 922,500 | 59 | 1,143,500 | 63 | 803,100 | 62 | 786,600 | 70 |
| April, | • | • | • | • | • | 971,100 | 62 | 1,112,300 | 61 | 788,800 | 61 | 839,200 | 75 |
| May, | • | • | • | • | • | 1,022,900 | 65 | 1,162,000 | 63 | 837,800 | 65 | 927,100 | 83 |
| June, | • | • | • | • | • | 1,043,000 | 66 | 1,309,300 | 71 | 832,500 | 64 | 944,400 | 84 |
| July, | • | • | • | • | • | 1,082,300 | 69 | 1,597,800 | 80 | 1,135,500 | 88 | 1,423,300 | 126 |
| August, | • | • | • | • | • | 1,141,800 | 72 | 1,711,300 | 92 | 976,000 | 75 | 1,184,000 | 105 |
| September, | • | • | • | • | • | 1,041,700 | 66 | 1,376,400 | 74 | 907,300 | 70 | 961,500 | 85 |
| October, | • | • | • | • | • | 1,055,700 | 67 | 1,275,500 | 68 | 961,800 | 74 | 911,900 | 80 |
| November, | • | • | • | • | • | 977,400 | 62 | 1,147,100 | 61 | 865,500 | 66 | 809,900 | 71 |
| December, | • | • | • | • | • | 988,500 | 61 | 1,348,800 | 71 | 905,300 | 69 | 846,600 | 74 |
| For the year, | • | • | • | • | • | 1,005,700 | 64 | 1,313,400 | 71 | 880,800 | 68 | 938,200 | 83 |
| | | | | | | | | | | 309,200 | 39 | 649,500 | 63 |

TABLE No. 24.—*Average Daily Consumption of Water in Cities and Towns, etc.—Concluded.*

| MONTH. | Per Day. | Per Capita. | GALLONS. | LEXINGTON. | NAHANT. | SWAMPSCOTT. | METROPOLITAN DISTRICT. | |
|----------------------|-----------|-------------|----------|---------------------|-----------|-------------|---------------------------|---------------------|
| | | | | | | | 1,022,250. | |
| | | | | | | | 6,960. ¹ | 2,100. ² |
| Population supplied, | | | 5,600. | 4,440. ¹ | | | | |
| Population supplied, | | | 7,130. | | | | | |
| January, | | | 621,300 | 88 | 229,600 | 42 | 255,300 | 58 |
| February, | | | 693,200 | 98 | 250,800 | 46 | 285,400 | 65 |
| March, | | | 653,600 | 92 | 282,500 | 51 | 258,200 | 59 |
| April, | | | 638,200 | 90 | 296,000 | 53 | 316,700 | 72 |
| May, | | | 688,200 | 97 | 336,300 | 60 | 343,700 | 78 |
| June, | | | 674,600 | 95 | 341,800 | 61 | 324,900 | 73 |
| July, | | | 803,600 | 113 | 511,700 | 91 | 528,400 | 119 |
| August, | | | 626,000 | 88 | 427,100 | 76 | 417,000 | 94 |
| September, | | | 586,900 | 82 | 331,900 | 59 | 379,200 | 85 |
| October, | | | 626,900 | 87 | 334,000 | 59 | 376,300 | 84 |
| November, | | | 633,500 | 88 | 313,600 | 55 | 318,200 | 71 |
| December, | | | 567,500 | 79 | 291,700 | 51 | 305,900 | 75 |
| For the year, | | | 650,800 | 91 | 329,500 | 59 | 345,500 | 78 |
| | | | | | 121,700 | 58 | 412,800 | 59 |
| | | | | | | | 112,092,100 | 110 |

¹ Allowance made for district not supplied.² Allowance for summer population.

TABLE No. 25.—(*Pump Basis.*) Consumption of Water in the Metropolitan Water District, as constituted in the Year 1910, and a Small Section of the Town of Saugus, from 1893 to 1910.

[Gallons per day.]

| MONTH. | 1893. | 1894. | 1895. | 1896. | 1897. | 1898. |
|-----------------------|------------|------------|------------|------------|------------|------------|
| January, | 75,209,000 | 67,506,000 | 68,925,000 | 82,946,000 | 85,366,000 | 83,880,000 |
| February, | 71,900,000 | 68,944,000 | 80,375,000 | 87,021,000 | 83,967,000 | 87,475,000 |
| March, | 67,638,000 | 62,710,000 | 69,543,000 | 86,111,000 | 82,751,000 | 85,468,000 |
| April, | 62,309,000 | 57,715,000 | 62,909,000 | 77,529,000 | 79,914,000 | 76,574,000 |
| May, | 61,025,000 | 60,676,000 | 65,194,000 | 73,402,000 | 76,772,000 | 76,677,000 |
| June, | 63,374,000 | 68,329,000 | 69,905,000 | 77,639,000 | 77,952,000 | 83,463,000 |
| July, | 69,343,000 | 73,642,000 | 69,667,000 | 80,000,000 | 85,525,000 | 88,228,000 |
| August, | 66,983,000 | 67,995,000 | 72,233,000 | 78,537,000 | 84,103,000 | 87,558,000 |
| September, | 64,654,000 | 67,137,000 | 73,724,000 | 74,160,000 | 84,296,000 | 88,296,000 |
| October, | 63,770,000 | 62,735,000 | 67,028,000 | 71,762,000 | 79,551,000 | 81,770,000 |
| November, | 61,204,000 | 62,231,000 | 64,881,000 | 71,933,000 | 72,762,000 | 78,177,000 |
| December, | 66,700,000 | 65,108,000 | 70,443,000 | 79,449,000 | 76,594,000 | 86,355,000 |
| Average, | 66,165,000 | 65,382,000 | 69,499,000 | 78,360,000 | 80,793,000 | 83,651,000 |
| Population, | 723,153 | 743,354 | 763,557 | 786,385 | 809,213 | 832,042 |
| Per capita, | 91.5 | 88.0 | 91.0 | 99.7 | 99.8 | 100.5 |

| MONTH. | 1899. | 1900. | 1901. | 1902. | 1903. | 1904. |
|-----------------------|-------------|-------------|-------------|-------------|-------------|-------------|
| January, | 96,442,000 | 100,055,000 | 111,275,000 | 118,435,000 | 125,176,000 | 137,771,000 |
| February, | 103,454,000 | 98,945,000 | 117,497,000 | 117,268,000 | 122,728,000 | 143,222,000 |
| March, | 90,200,000 | 97,753,000 | 105,509,000 | 108,461,000 | 111,977,000 | 123,334,000 |
| April, | 86,491,000 | 89,497,000 | 93,317,000 | 103,153,000 | 107,179,000 | 108,688,000 |
| May, | 89,448,000 | 87,780,000 | 95,567,000 | 106,692,000 | 111,589,000 | 111,715,000 |
| June, | 97,691,000 | 98,581,000 | 103,420,000 | 110,002,000 | 105,590,000 | 111,209,000 |
| July, | 96,821,000 | 107,786,000 | 106,905,000 | 108,340,000 | 107,562,000 | 113,584,000 |
| August, | 92,072,000 | 102,717,000 | 102,815,000 | 107,045,000 | 103,570,000 | 112,836,000 |
| September, | 91,478,000 | 103,612,000 | 102,103,000 | 107,752,000 | 106,772,000 | 114,188,000 |
| October, | 89,580,000 | 98,358,000 | 103,389,000 | 106,560,000 | 103,602,000 | 108,290,000 |
| November, | 86,719,000 | 93,648,000 | 101,324,000 | 105,175,000 | 103,477,000 | 108,054,000 |
| December, | 85,840,000 | 97,844,000 | 113,268,000 | 125,434,000 | 114,721,000 | 125,119,000 |
| Average, | 92,111,000 | 98,059,000 | 104,645,000 | 110,345,000 | 110,277,000 | 118,114,000 |
| Population, | 854,870 | 877,698 | 892,740 | 907,780 | 922,820 | 937,860 |
| Per capita, | 107.8 | 111.7 | 117.2 | 121.6 | 119.5 | 125.9 |

TABLE No. 25.—(*Pump Basis.*) Consumption of Water, etc.—Concluded.
[Gallons per day.]

| MONTH. | 1905. | 1906. | 1907. | 1908. | 1909. | 1910. |
|-----------------------|-------------|-------------|-------------|-------------|-------------|-------------|
| January, | 130,878,000 | 126,093,000 | 137,730,000 | 132,376,000 | 133,275,000 | 127,568,000 |
| February, | 140,595,000 | 130,766,000 | 150,822,000 | 146,199,000 | 130,763,000 | 131,093,000 |
| March, | 120,879,000 | 123,570,000 | 134,202,000 | 128,884,000 | 126,842,000 | 117,078,000 |
| April, | 111,898,000 | 118,428,000 | 121,556,000 | 128,926,000 | 125,335,000 | 112,775,000 |
| May, | 115,804,000 | 122,404,000 | 123,502,000 | 131,040,000 | 123,305,000 | 112,073,000 |
| June, | 117,441,000 | 121,882,000 | 125,623,000 | 139,843,000 | 125,179,000 | 114,082,000 |
| July, | 124,769,000 | 118,726,000 | 128,779,000 | 138,232,000 | 126,765,000 | 122,743,000 |
| August, | 121,158,000 | 120,591,000 | 131,098,000 | 128,073,000 | 121,781,000 | 118,373,000 |
| September, | 120,103,000 | 121,685,000 | 124,751,000 | 129,972,000 | 118,043,000 | 112,434,000 |
| October, | 118,301,000 | 116,561,000 | 124,051,000 | 124,189,000 | 115,939,000 | 112,332,000 |
| November, | 116,693,000 | 113,746,000 | 119,627,000 | 117,119,000 | 111,664,000 | 107,528,000 |
| December, | 122,696,000 | 130,995,000 | 122,407,000 | 124,468,000 | 115,733,000 | 121,994,000 |
| Average, | 121,671,000 | 122,085,000 | 128,581,000 | 130,712,000 | 122,851,000 | 117,458,000 |
| Population, | 955,920 | 981,690 | 1,007,520 | 1,025,890 | 1,051,420 | 1,076,930 |
| Per capita, | 127.3 | 124.4 | 127.6 | 127.4 | 116.8 | 109.1 |

This table includes the water consumed in the cities and towns enumerated in Table No. 21, together with the water consumed in Newton and Hyde Park, which are included in the Metropolitan Water District, but have not been supplied from the Metropolitan Works. The populations for the years 1901 to 1909 were revised after the census of 1901 and of 1910 became available, and consequently the figures in the reports after 1904 and 1909 differ from those published in a corresponding table in the preceding annual reports.

METROPOLITAN WATER

[Pub. Doc.]

TABLE No. 26.—Chemical Examinations of Water from the Wachusett Reservoir, Clinton.

[Parts per 100,000.]

| Number. | Date of Collection. | APPEARANCE. | Turbidity. | Color. Platinum Bediment. | ODOR. | Cold. | Hot. | RESIDUE ON EVAP- ORATION. | | | AMMONIA. | | | NITROGEN AS Suspended. | | | Oxygen consumed. Hardness. | | | | | | |
|---------|---------------------|-------------|------------|---------------------------------|--------------------------------------|-------|------|---------------------------------|------------|------------|-------------|-------------|-----------|------------------------------|-------|---------|-------------------------------|-------|-------|-----|-------|-------|---------|
| | | | | | | | | Total. | | Dissolved. | | Albuminoid. | | Chlorine. | | | | | | | | | |
| | | | | | | | | Free. | Suspended. | Dissolved. | Albuminoid. | Nitrates. | Nitrites. | | | | | | | | | | |
| 83029 | 1910. Jan. 4 | V. slight. | None. | 18 | Faintly vegetable. | | | 3.25 | 1.60 | .0024 | .0110 | .0102 | .0008 | .25 | .0010 | .0000 | .33 1.3 | | | | | | |
| 83298 | Jan. 18 | V. slight. | V. slight. | 8 | V. faintly vegetable. | | | 2.75 | 1.05 | .0030 | .0170 | .0140 | .0030 | .25 | .0010 | .0000 | .22 1.3 | | | | | | |
| 83523 | Feb. 1 | V. slight. | Slight. | 22 | V. faintly vegetable and unpleasant. | | | 2.75 | 1.20 | .0046 | .0246 | .0224 | .0022 | .27 | .0020 | .0000 | .51 0.6 | | | | | | |
| 83784 | Feb. 15 | None. | V. slight. | 15 | V. faintly vegetable. | | | 2.95 | 1.05 | .0020 | .0104 | .0086 | .0018 | .27 | .0030 | .0000 | .37 1.3 | | | | | | |
| 84001 | Mar. 15 | V. slight. | V. slight. | 22 | V. faintly vegetable. | | | 3.50 | 1.60 | .0030 | .0158 | .0128 | .0030 | .29 | .0020 | .0000 | .35 1.3 | | | | | | |
| 84172 | Mar. 15 | V. slight. | V. slight. | 20 | Faintly vegetable. | | | 3.20 | 1.10 | .0014 | .0130 | .0096 | .0034 | .26 | .0020 | .0000 | .30 0.8 | | | | | | |
| 84586 | Apr. 7 | V. slight. | V. slight. | 16 | Faintly unpleasant. | | | 2.70 | 0.95 | .0014 | .0134 | .0114 | .0020 | .23 | .0010 | .0000 | .37 1.3 | | | | | | |
| 84740 | Apr. 19 | V. slight. | Slight. | 15 | V. faintly vegetable. | | | 3.00 | 1.05 | .0014 | .0106 | .0100 | .0006 | .25 | .0010 | .0001 | .24 1.3 | | | | | | |
| 84980 | May 3 | V. slight. | V. slight. | 17 | V. faintly vegetable. | | | 2.85 | 1.05 | .0008 | .0126 | .0104 | .0022 | .25 | .0010 | .0001 | .25 0.8 | | | | | | |
| 85184 | May 17 | V. slight. | V. slight. | 12 | V. faintly vegetable. | | | 2.75 | 0.95 | .0008 | .0130 | .0118 | .0012 | .25 | .0020 | .0000 | .24 0.8 | | | | | | |
| 85534 | June 7 | V. slight. | Slight. | 16 | V. faintly vegetable. | | | 3.10 | 1.10 | .0006 | .0110 | .0088 | .0022 | .25 | .0010 | .0000 | .24 0.8 | | | | | | |
| 85917 | June 21 | V. slight. | V. slight. | 13 | V. faintly vegetable. | | | 2.45 | 1.05 | .0020 | .0104 | .0088 | .0016 | .28 | .0010 | .0000 | .29 0.5 | | | | | | |
| 86106 | July 5 | V. slight. | V. slight. | 13 | V. faintly vegetable and unpleasant. | | | 3.05 | 1.00 | .0010 | .0102 | .0092 | .0010 | .22 | .0000 | .0001 | .28 0.8 | | | | | | |
| 86776 | Aug. 2 | V. slight. | V. slight. | 11 | V. faintly vegetable. | | | 3.55 | 1.55 | .0014 | .0104 | .0094 | .0010 | .25 | .0000 | .0000 | .22 1.0 | | | | | | |
| 87192 | Aug. 23 | V. slight. | V. slight. | 11 | Faintly vegetable. | | | 3.05 | 1.10 | .0014 | .0150 | .0134 | .0016 | .24 | .0010 | .0000 | .25 0.8 | | | | | | |
| 87798 | Sept. 20 | None. | V. slight. | 10 | V. faintly vegetable. | | | 2.70 | 1.15 | .0008 | .0094 | .0084 | .0010 | .25 | .0000 | .0000 | .24 0.6 | | | | | | |
| 88116 | Oct. 4 | V. slight. | V. slight. | 13 | V. faintly vegetable. | | | 2.75 | 1.00 | .0010 | .0132 | .0126 | .0012 | .26 | .0010 | .0000 | .24 0.8 | | | | | | |
| 88442 | Oct. 18 | V. slight. | V. slight. | 9 | V. faintly vegetable. | | | 2.85 | 1.00 | .0018 | .0106 | .0006 | .0026 | .0000 | .0000 | .23 0.8 | | | | | | | |
| 89021 | Nov. 8 | None. | V. slight. | 10 | V. faintly vegetable. | | | 2.80 | 1.00 | .0032 | .0124 | .0112 | .0020 | .0000 | .0000 | .28 0.8 | | | | | | | |
| 89423 | Nov. 21 | None. | V. slight. | 11 | V. faintly vegetable. | | | 3.35 | 1.55 | .0020 | .0156 | .0104 | .0004 | .26 | .0020 | .0000 | .22 0.8 | | | | | | |
| 89626 | Dec. 6 | V. slight. | V. slight. | 11 | V. faintly vegetable. | | | 3.60 | 1.60 | .0020 | .0144 | .0128 | .0016 | .26 | .0000 | .0000 | .17 0.8 | | | | | | |
| 89905 | Dec. 20 | V. slight. | V. slight. | 10 | V. faintly vegetable. | | | 2.55 | 1.15 | .0014 | .0094 | .0080 | .0014 | .26 | .0010 | .0000 | .22 0.8 | | | | | | |
| Av. | | | | | | | | 2.20 | 1.00 | .0020 | .0148 | .0138 | .0010 | .27 | .0010 | .0000 | .23 0.8 | | | | | | |
| | | | | | | | | 14 | | | | | | 2.94 | 1.17 | .0018 | .0130 | .0115 | .0016 | .26 | .0010 | .0000 | .28 0.9 |

TABLE No. 27.—Chemical Examinations of Water from Sudbury Reservoir.

[Parts per 100,000.]

| Number. | Date of Collection. | APPEARANCE. | | | ODOR. | | | RESIDUE ON EVAPORATION. | | | AMMONIA. | | | NITROGEN AS | | | Oxygen consumed. | Hardness. |
|---------|---------------------|-------------|------------|------------|--------------------------------------|--------------------------------------|--------|-------------------------|------------|------------|-------------|-----------|-----------|-------------|-------|-----|------------------|-----------|
| | | Turbidity. | Color. | Bediaffet. | Cold. | Hot. | Total. | Free. | Dissolved. | Suspended. | Albuminoid. | Chlorine. | Nitrites. | Nitrate. | | | | |
| | | | | | | | | | | | | | | | | | | |
| 83042 | 1910, Jan. 4 | None. | None. | 10 | V. faintly vegetable. | Faintly vegetable. | 2.80 | 1.00 | .0020 | .0142 | .0116 | .0026 | .26 | .0020 | .0000 | .27 | 1.3 | |
| 83477 | Jan. 31 | V. slight. | V. slight. | 12 | None. | V. faintly vegetable. | 3.15 | 1.45 | .0016 | .0112 | .0100 | .0012 | .27 | .0050 | .0000 | .22 | 1.3 | |
| 83983 | Mar. 2 | V. slight. | V. slight. | 15 | V. faintly vegetable. | Faintly vegetable. | 3.95 | 1.60 | .0030 | .0108 | .0102 | .0006 | .28 | .0060 | .0000 | .24 | 1.3 | |
| 84485 | Apr. 4 | V. slight. | V. slight. | 20 | V. faintly vegetable. | Faintly vegetable. | 3.70 | 1.75 | .0016 | .0156 | .0108 | .0048 | .33 | .0050 | .0001 | .34 | 1.3 | |
| 84940 | May 2 | V. slight. | Slight. | 15 | Faintly vegetable. | Distinctly vegetable. | 3.05 | 1.10 | .0032 | .0108 | .0094 | .0014 | .29 | .0040 | .0001 | .30 | 1.3 | |
| 85494 | June 6 | V. slight. | Slight. | 18 | Faintly vegetable. | Faintly vegetable. | 2.90 | 1.05 | .0030 | .0152 | .0130 | .0022 | .29 | .0010 | .0001 | .27 | 1.0 | |
| 86991 | July 5 | V. slight. | V. slight. | 14 | Faintly vegetable. | Faintly vegetable. | 2.65 | 1.10 | .0034 | .0166 | .0130 | .0036 | .30 | .0000 | .0000 | .27 | 1.0 | |
| 86712 | Aug. 1 | V. slight. | Slight. | 13 | V. faintly vegetable. | V. faintly vegetable. | 2.75 | 1.00 | .0026 | .0142 | .0132 | .0010 | .27 | .0000 | .0000 | .23 | 1.0 | |
| 87483 | Sept. 6 | Slight. | Slight. | 13 | V. faintly vegetable. | Faintly vegetable. | 3.50 | 1.15 | .0006 | .0096 | .0078 | .0018 | .23 | .0040 | .0000 | .28 | 1.0 | |
| 88152 | Oct. 5 | None. | V. slight. | 9 | V. faintly vegetable. | Faintly vegetable. | 2.60 | 0.90 | .0010 | .0132 | .0108 | .0024 | .28 | .0000 | .0000 | .18 | 0.8 | |
| 88863 | Nov. 2 | V. slight. | V. slight. | 11 | V. faintly vegetable and unpleasant. | Faintly vegetable and unpleasant. | 3.55 | 1.45 | .0020 | .0148 | .0126 | .0022 | .27 | .0010 | .0000 | .21 | 0.8 | |
| 89588 | Dec. 5 | V. slight. | V. slight. | 10 | V. faintly vegetable. | V. faintly vegetable, faintly fishy. | 2.30 | 1.00 | .0006 | .0114 | .0104 | .0010 | .27 | .0020 | .0000 | .18 | 0.8 | |
| Av. | ..... | ..... | ..... | 13 | ..... | ..... | 3.07 | 1.21 | .0021 | .0131 | .0111 | .0021 | .28 | .0025 | .0000 | .25 | 1.1 | |

METROPOLITAN WATER

[Pub. Doc.

TABLE No. 28.—*Chemical Examinations of Water from Spot Pond, Stoneham.*

[Parts per 100,000.]

| Number. | Date of Collection. | APPEARANCE. | | ODOR. | | RESIDUE ON EVAPORATION. | | AMMONIA. | | NITROGEN AS | | Oxygen consumed. | Hardness. | | | |
|----------|---------------------|-------------|---|-------|-----------------------------------|-------------------------|------------|-------------|-----------|-------------|-------|------------------|-----------|-------|-----|-----|
| | | Turbidity. | Color. Platinum Sulfide standard. | Cold. | Hot. | Loss on Evaporation. | | Albuminoid. | | Chlorate. | | | | | | |
| | | | | | | Total. | Dissolved. | Suspended. | Nitrates. | Nitrites. | | | | | | |
| 83114 | 1910. Jan. 10 | None. | V. slight. | 10 | Faintly vegetable and unpleasant. | 3.95 | 1.20 | .0030 | .0148 | .0134 | .0014 | .38 | .0010 | .0001 | .20 | 1.3 |
| 83472 | Jan. 31 | V. slight. | V. slight. | 10 | V. faintly unpleasant. | 2.70 | 1.00 | .0020 | .0134 | .0126 | .0008 | .33 | .0000 | .0000 | .16 | 1.3 |
| 83970 | Mar. 2 | V. slight. | V. slight. | 10 | None. | 3.50 | 1.10 | .0040 | .0162 | .0116 | .0046 | .32 | .0010 | .0000 | .19 | 1.3 |
| 84467 | Apr. 4 | V. slight. | Slight. | 10 | Faintly unpleasant and fishy. | 2.90 | 1.30 | .0022 | .0156 | .0114 | .0042 | .34 | .0020 | .0002 | .21 | 1.3 |
| 84935 | May 2 | V. slight. | Slight, also scum. | 9 | Faintly unpleasant and fishy. | 2.90 | 1.25 | .0012 | .0146 | .0142 | .0004 | .35 | .0010 | .0000 | .18 | 1.3 |
| 85487 | June 6 | V. slight. | V. slight. | 10 | V. faintly unpleasant. | 3.40 | 1.35 | .0010 | .0158 | .0122 | .0016 | .34 | .0000 | .0001 | .19 | 1.6 |
| 86083 | July 5 | V. slight. | V. slight. | 10 | V. faintly unpleasant. | 4.45 | 1.70 | .0010 | .0162 | .0138 | .0024 | — | .0000 | .0000 | .15 | 1.1 |
| 86707 | Aug. 1 | V. slight. | V. slight. | 12 | None. | 3.90 | 1.50 | .0012 | .0132 | .0124 | .0008 | .31 | .0000 | .0000 | .23 | 1.3 |
| 87499 | Sept. 7 | V. slight. | Slight. | 11 | V. faintly vegetable. | 3.45 | 1.10 | .0008 | .0136 | .0108 | .0028 | .33 | .0000 | .0000 | .22 | 1.1 |
| 88226 | Oct. 10 | V. slight. | V. slight. | 5 | Faintly unpleasant. | 3.95 | 1.55 | .0004 | .0120 | .0102 | .0018 | .33 | .0000 | .0000 | .16 | 1.3 |
| 88967 | Nov. 7 | V. slight. | V. slight. | 4 | V. faintly vegetable. | 3.30 | 1.45 | .0012 | .0156 | .0136 | .0020 | .31 | .0000 | .0000 | .16 | 0.8 |
| 89013 | Dec. 6 | V. slight. | V. slight. | 0 | V. faintly vegetable. | 3.50 | 1.50 | .0012 | .0142 | .0108 | .0034 | .32 | .0000 | .0000 | .19 | 1.3 |
| Av. .... | .... | .... | .... | 8 | .... | 3.49 | 1.33 | .0016 | .0144 | .0123 | .0022 | .33 | .0004 | .0000 | .19 | 1.3 |

TABLE No. 29.—Chemical Examinations of Water from Lake Cochituate.

[Parts per 100,000.]

| Number. | Date of Collection. | APPEARANCE. | | ODOR. | | RESIDUE ON EVAPORATION. | | AMMONIA. | | NITROGEN AS NITRATES. | | OXYGEN CONSUMED. | | Hardness. | | |
|---------|---------------------|-------------|-----------------------------------|-------|---|-------------------------|-------|-------------|------------|-----------------------|----------|------------------|-------|-----------|-----|-----|
| | | Turbidity. | Color. Platinum Bichromate. | Cold. | Hot. | Loss on Digestion. | | Albuminoid. | | Chloride. | | Nitrate. | | | | |
| | | | | | | Total. | Free. | Dissolved. | Suspended. | Nitrate. | Nitrite. | | | | | |
| 83074 | 1910. Jan. 3 | V. slight. | V. slight. | 26 | V. faintly vegetable. | 6.05 | 1.85 | .0032 | .0214 | .0172 | .0042 | .64 | .0000 | .0000 | .33 | 2.2 |
| 83487 | Jan. 31 | V. slight. | Slight. | 30 | Distinctly unpleasant, decaying organisms. | 6.40 | 2.65 | .0018 | .0198 | .0164 | .0034 | .63 | .0030 | .0000 | .41 | 2.2 |
| 83955 | Mar. 1 | Slight. | Slight. | 35 | Faintly vegetable and unpleasant. | 5.50 | 2.05 | .0050 | .0176 | .0144 | .0032 | .50 | .0040 | .0000 | .45 | 2.0 |
| 84491 | Apr. 4 | V. slight. | V. slight. | 23 | Distinctly unpleasant. | 6.05 | 2.10 | .0012 | .0200 | .0142 | .0058 | .58 | .0030 | .0001 | .38 | 2.2 |
| 84974 | May 2 | V. slight. | Slight. | 25 | Distinctly unpleasant, decaying organisms. | 5.35 | 1.85 | .0024 | .0216 | .0166 | .0050 | .60 | .0030 | .0001 | .43 | 2.6 |
| 85499 | June 6 | V. slight. | Slight. | 20 | Faintly vegetable. | 6.15 | 2.20 | .0020 | .0238 | .0164 | .0074 | .61 | .0010 | .0001 | .37 | 2.2 |
| 86108 | July 5 | V. slight. | V. slight. | 20 | Faintly vegetable. | 6.65 | 2.30 | .0028 | .0216 | .0184 | .0032 | .67 | .0000 | .0001 | .39 | 2.5 |
| 86719 | Aug. 1 | V. slight. | Slight. | 42 | V. faintly vegetable. | 5.35 | 1.80 | .0008 | .0172 | .0168 | .0004 | .62 | .0000 | .0000 | .35 | 2.2 |
| 87469 | Sept. 6 | V. slight. | V. slight. | 15 | V. faintly vegetable. | 5.95 | 1.80 | .0008 | .0204 | .0184 | .0020 | .64 | .0000 | .0000 | .34 | 2.5 |
| 88103 | Oct. 3 | V. slight. | V. slight. | 12 | Faintly unpleasant, de- caying organisms. | 5.85 | 2.30 | .0006 | .0200 | .0164 | .0036 | .66 | .0010 | .0000 | .35 | 2.2 |
| 88997 | Nov. 7 | V. slight. | V. slight. | 13 | Faintly vegetable. | 5.65 | 2.40 | .0030 | .0192 | .0162 | .0030 | .63 | .0000 | .0000 | .28 | 2.2 |
| 89585 | Dec. 5 | V. slight. | Slight. | 16 | V. faintly vegetable. | 6.30 | 2.80 | .0060 | .0200 | .0146 | .0054 | .60 | .0010 | .0002 | .29 | 2.5 |
| Av. | ..... | ..... | ..... | 23 | ..... | 5.94 | 2.18 | .0025 | .0202 | .0163 | .0039 | .62 | .0010 | .0001 | .36 | 2.3 |

TABLE No. 30.—*Chemical Examinations of Water from a Tap at the State House, Boston.*

[Parts per 100,000.]

| Number. | Date of Collection. | APPEARANCE. | | | ODOR. | | | AMMONIA. | | | Oxygen Consumed. | Hardness. | | |
|---------|---------------------|-------------|------------|-----------|-----------------------|-----------------------|--------|----------|-------------|------------|------------------|-----------|-----------------|-----|
| | | Turbidity. | Color. | Sediment. | Cold. | Hot. | Total. | Free. | ALBUMINOID. | | | | | |
| | | | | | | | | | Dissolved. | Suspended. | Chlorine. | | | |
| 83008 | 1910. Jan. 3 | None. | V. slight. | 16 | None. | V. faintly vegetable. | 2.40 | 1.00 | .0024 | .0118 | .0112 | .26 | .0030 .0000 .18 | 1.3 |
| 83475 | Jan. 31 | None. | V. slight. | 15 | V. faintly vegetable. | Faintly vegetable. | 3.05 | 1.35 | .0026 | .0120 | .0100 | .26 | .0060 .0000 .22 | 1.3 |
| 83927 | Feb. 28 | V. slight. | V. slight. | 17 | Faintly vegetable. | Faintly vegetable. | 4.10 | 2.00 | .0026 | .0110 | .0090 | .27 | .0050 .0000 .25 | 1.3 |
| 84468 | Apr. 4 | V. slight. | Slight. | 17 | Faintly vegetable. | Faintly vegetable. | 3.70 | 1.60 | .0016 | .0124 | .0100 | .32 | .0090 .0002 .25 | 1.3 |
| 84932 | May 2 | V. slight. | Slight. | 20 | Faintly vegetable. | Faintly vegetable. | 3.20 | 1.10 | .0014 | .0116 | .0112 | .32 | .0080 .0000 .24 | 1.3 |
| 85478 | June 6 | V. slight. | Slight. | 17 | V. faintly vegetable. | V. faintly vegetable. | 3.30 | 1.20 | .0012 | .0152 | .0118 | .29 | .0020 .0001 .27 | 1.3 |
| 86095 | July 5 | V. slight. | Slight. | 12 | Faintly vegetable. | Faintly vegetable. | 3.25 | 1.25 | .0010 | .0144 | .0112 | .30 | .0010 .0000 .19 | 0.8 |
| 86793 | Aug. 4 | V. slight. | Slight. | 11 | V. faintly vegetable. | V. faintly vegetable. | 3.20 | 1.15 | .0002 | .0086 | .0086 | .29 | .0000 .0001 .23 | 0.8 |
| 87477 | Sept. 7 | V. slight. | Slight. | 12 | Faintly vegetable. | Faintly vegetable. | 2.95 | 1.00 | .0002 | .0108 | .0098 | .25 | .0000 .0001 .23 | 0.8 |
| 88099 | Oct. 4 | V. slight. | V. slight. | 10 | V. faintly vegetable. | Faintly vegetable. | 2.20 | 1.05 | .0006 | .0114 | .0094 | .26 | .0010 .0000 .25 | 0.8 |
| 88886 | Nov. 3 | None. | V. slight. | 10 | V. faintly vegetable. | V. faintly vegetable. | 2.70 | 1.00 | .0010 | .0114 | .0102 | .27 | .0000 .0000 .21 | 1.3 |
| 89579 | Dec. 5 | V. slight. | V. slight. | 10 | None. | V. faintly vegetable. | 2.55 | 1.15 | .0008 | .0108 | .0092 | .27 | .0010 .0000 .16 | 1.3 |
| Av. | ..... | ..... | ..... | 14 | ..... | ..... | 3.05 | 1.24 | .0013 | .0118 | .0102 | .28 | .0030 .0000 .22 | 1.1 |

TABLE No. 31.—*Averages of Examinations of Water from Various Parts of the Metropolitan Water Works in 1910.*

Parts per 100,000,1

Average of 6 samples.

2 Average of 11 samples.

TABLE No. 32.—*Chemical Examinations of Water from a Faucet in Boston, from 1892 to 1910.*

[Parts per 100,000.]

| YEAR. | COLOR. | | RESIDUE ON EVAPORATION. | | AMMONIA. | | | | NITROGEN AS | | Oxygen Consumed. Hardness. | |
|-------------|----------------------|-----------------------|-------------------------|----------------------|-------------|--------|------------|-----------|-------------|-----------|-------------------------------|---------|
| | Nessler Standard. | Platinum Standard. | Total. | Loss on Ignition. | ALBUMINOID. | | | Chlorine. | Nitrates. | Nitrites. | | |
| | | | | | Free. | Total. | Dissolved. | | | | | |
| 1892, . . . | .37 | 37 | 4.70 | 1.67 | .0007 | .0168 | .0138 | .0030 | .41 | .0210 | .0001 | - 1.9 |
| 1893, . . . | .61 | 53 | 4.54 | 1.84 | .0010 | .0174 | .0147 | .0027 | .38 | .0143 | .0001 | .60 1.8 |
| 1894, . . . | .69 | 58 | 4.64 | 1.83 | .0006 | .0169 | .0150 | .0019 | .41 | .0106 | .0001 | .63 1.7 |
| 1895, . . . | .72 | 59 | 4.90 | 2.02 | .0006 | .0197 | .0175 | .0022 | .40 | .0171 | .0001 | .69 0.7 |
| 1896, . . . | .49 | 45 | 4.29 | 1.67 | .0005 | .0165 | .0142 | .0023 | .37 | .0155 | .0001 | .56 1.4 |
| 1897, . . . | .65 | 55 | 4.82 | 1.84 | .0009 | .0193 | .0177 | .0016 | .40 | .0137 | .0001 | .64 1.6 |
| 1898, . . . | .41 | 40 | 4.19 | 1.60 | .0008 | .0152 | .0136 | .0016 | .29 | .0097 | .0001 | .44 1.4 |
| 1899, . . . | .23 | 28 | 3.70 | 1.30 | .0006 | .0136 | .0122 | .0014 | .24 | .0137 | .0001 | .35 1.1 |
| 1900, . . . | .24 | 29 | 3.80 | 1.20 | .0012 | .0157 | .0139 | .0018 | .25 | .0076 | .0001 | .38 1.3 |
| 1901, . . . | .24 | 29 | 4.43 | 1.64 | .0013 | .0158 | .0142 | .0016 | .30 | .0173 | .0001 | .42 1.7 |
| 1902, . . . | .26 | 30 | 3.93 | 1.56 | .0016 | .0139 | .0119 | .0020 | .29 | .0092 | .0000 | .40 1.3 |
| 1903, . . . | .25 | 29 | 3.98 | 1.50 | .0013 | .0125 | .0110 | .0015 | .30 | .0142 | .0001 | .39 1.5 |
| 1904, . . . | - | 23 | 3.93 | 1.59 | .0023 | .0139 | .0121 | .0018 | .34 | .0110 | .0001 | .37 1.5 |
| 1905, . . . | - | 24 | 3.86 | 1.59 | .0020 | .0145 | .0124 | .0021 | .35 | .0083 | .0001 | .35 1.4 |
| 1906, . . . | - | 24 | 3.86 | 1.39 | .0018 | .0159 | .0134 | .0025 | .34 | .0054 | .0001 | .36 1.3 |
| 1907, . . . | - | 22 | 3.83 | 1.40 | .0013 | .0129 | .0109 | .0020 | .33 | .0068 | .0001 | .32 1.3 |
| 1908, . . . | - | 19 | 3.50 | 1.35 | .0011 | .0115 | .0092 | .0024 | .33 | .0092 | .0001 | .26 1.2 |
| 1909, . . . | - | 18 | 3.46 | 1.43 | .0011 | .0128 | .0103 | .0025 | .28 | .0034 | .0000 | .25 1.3 |
| 1910, . . . | - | 14 | 3.05 | 1.24 | .0013 | .0118 | .0102 | .0016 | .28 | .0030 | .0000 | .22 1.1 |

Note relating to Chemical Examinations of Water, Tables Nos. 26-32.

The chemical examinations contained in the tables were made by the State Board of Health. Previous to the year 1904 colors were determined by the Nessler standard, but the corresponding values by the platinum standard are also given, for the purpose of comparison with colors determined in the laboratory of the Metropolitan Water and Sewerage Board, as given in subsequent tables. The odor recorded is taken in such a way that it is a much stronger odor than would be noticed in samples drawn directly from a tap or collected directly from a reservoir. The important samples are collected and examined semi-monthly or monthly.

TABLE No. 33.—*Microscopic Organisms in Water from Various Parts of the Metropolitan Water Works, from 1898 to 1910, inclusive.*

[Standard units per cubic centimeter; averages from weekly or biweekly observations.]

| YEAR. | WACHUSSETT RESERVOIR. | SUDSBURY RESERVOIR. | LAKE COCHITTAUET. | FRAMINGHAM RESERVOIR. | | ASHLAND RESERVOIR. | HOPKINTON RESERVOIR. | WHITEHALL RESERVOIR. | | | |
|-------|--------------------------|------------------------|----------------------|--------------------------|----------|-----------------------|-------------------------|-------------------------|--|--|--|
| | | | | No. 2. | | | | | | | |
| | | | | No. 3. | Surface. | | | | | | |
| | Surface. | Bottom. | Surface. | Bottom. | Surface. | Mid-depth. | Surface. | Surface. | | | |
| 1898, | - | - | - | 354 | 149 | 830 | 696 | 390 | | | |
| 1899, | - | - | - | 470 | 252 | 905 | 644 | 440 | | | |
| 1900, | - | - | - | 498 | 361 | 1,753 | 1,071 | 645 | | | |
| 1901, | - | - | - | 337 | 225 | 992 | 702 | 336 | | | |
| 1902, | - | - | - | 590 | 402 | 1,071 | 730 | 627 | | | |
| 1903, | - | - | - | 549 | 388 | 931 | 795 | 459 | | | |
| 1904, | - | - | - | 313 | - | 517 | 376 | 663 | | | |
| 1905, | - | - | - | 769 | 592 | 644 | 502 | 1,255 | | | |
| 1906, | - | - | - | 446 | 272 | 953 | 714 | 1,143 | | | |
| 1907, | - | - | - | 425 | 212 | 513 | 419 | 1,123 | | | |
| 1908, | - | - | - | 731 | 466 | 850 | 885 | 1,559 | | | |
| 1909, | - | - | - | 2,151 | 1,937 | 2,474 | 2,513 | 1,142 | | | |
| 1910, | - | - | - | 480 | 328 | 464 | 556 | 928 | | | |
| Mean, | - | - | - | 759 | 635 | 709 | 596 | 1,120 | | | |

NOTE.—A large growth of *Asterionella* originated in the Wachusett Reservoir in 1909, causing the large number of organisms in the water of Sudbury Reservoir and Framingham Reservoir No. 3, Weston and Chestnut Hill reservoirs, Spot Pond and in the water drawn from taps.

METROPOLITAN WATER

[Pub. Doc.]

TABLE No. 33.—*Microscopic Organisms in Water, etc.—Concluded.*

[Standard units per cubic centimeter; averages from weekly or biweekly observations.]

| YEAR. | WESTON RESERVOIR. | SPOT POND. | CHESTNUT HILL RESERVOIR. | | | | TAPS. | | |
|-------|----------------------|------------|--------------------------|-----------------------|-------------------------|-------------------------|--------|-----------------------------|------------------------------|
| | | | Surface. | SUDSBURY AQUEDUCT. | COCHITUATE AQUEDUCT. | EFFLUENT GATE-HOUSE. | No. 2. | Southern Low Service. | Southern High Service. |
| | | | | Inlet. | Inlet. | No. 2. | | | |
| 1898, | - | - | - | 485 | 304 | 544 | 304 | 230 | - |
| 1899, | - | - | - | 1,129 | 359 | 992 | 329 | 192 | 201 |
| 1900, | - | - | - | 573 | 568 | 1,139 | 897 | 468 | 452 |
| 1901, | - | - | - | 628 | 344 | 697 | 413 | 243 | 280 |
| 1902, | - | - | - | 581 | 563 | 937 | 525 | 367 | 451 |
| 1903, | - | - | - | 650 | 450 | 860 | 435 | 286 | 398 |
| 1904, | - | - | - | 465 | 405 | 838 | 472 | 303 | 470 |
| 1905, | - | - | - | 609 | 551 | 904 | 554 | 528 | 671 |
| 1906, | - | - | - | 783 | 671 | 1,042 | 721 | 550 | 583 |
| 1907, | - | - | - | 443 | 590 | 349 | 909 | 419 | 312 |
| 1908, | - | - | - | 979 | 741 | 783 | 1,073 | 689 | 666 |
| 1909, | - | - | - | 2,399 | 1,079 | 1,999 | 632 | 1,899 | 1,913 |
| 1910, | - | - | - | 625 | 622 | 457 | - | 465 | 447 |
| Mean, | - | - | - | 1,046 | 679 | 597 | 881 | 625 | 500 |
| | | | | | | | | 584 | 449 |
| | | | | | | | | | 422 |

NOTE.—A large growth of *Asterionella* originated in the Wachusett Reservoir in 1909, causing the large number of organisms in the water of Sudbury Reservoir and Framingham Reservoir No. 3, Weston and Chestnut Hill reservoirs, Spot Pond and in the water drawn from taps.

TABLE No. 34.—*Number of Bacteria per Cubic Centimeter in Water from Various Parts of the Metropolitan Water Works, from 1898 to 1910, inclusive.*

[Averages of weekly determinations.]

| YEAR. | CHESTNUT HILL RESERVOIR. | | | SOUTHERN SERVICE TAPS. | |
|-----------------|------------------------------------|----------------------|----------------------------|-----------------------------------|----------------------------------|
| | Sudbury Aqueduct Terminal Chamber. | Cochituate Aqueduct. | Effluent Gate-house No. 2. | Low Service, 244 Boylston Street. | High Service, 1 Ashburton Place. |
| 1898, | 207 | 145 | 111 | 96 | - |
| 1899, | 224 | 104 | 217 | 117 | 123 |
| 1900, | 248 | 113 | 256 | 188 | 181 |
| 1901, | 225 | 149 | 169 | 162 | 168 |
| 1902, | 203 | 168 | 121 | 164 | 246 |
| 1903, | 76 | 120 | 96 | 126 | 243 |
| 1904, | 347 | 172 | 220 | 176 | 355 |
| 1905, | 495 | 396 | 489 | 231 | 442 |
| 1906, | 231 | 145 | 246 | 154 | 261 |
| 1907, | 147 | 246 | 118 | 130 | 176 |
| 1908, | 162 | 138 | 137 | 136 | 148 |
| 1909, | 198 | 229 | 119 | 150 | 195 |
| 1910, | 216 | - | 180 | 178 | 213 |
| Mean, | 229 | 177 | 191 | 154 | 229 |

TABLE No. 35.—*Colors of Water from Various Parts of the Metropolitan Water Works in 1910. (Means of Weekly Determinations.)*

[Platinum Standard.]

| MONTH. | WACHUSSETT RESERVOIR. | | | | | SUDBURY RESERVOIR. | | | FRAMINGHAM RESERVOIR. | | LAKE COCHITUATE. | | |
|----------------------|--------------------------|-----------------|-------------------|------------|---------|--------------------|---------|----------------------|-----------------------|--------|------------------|------------|---------|
| | Surface. | | Mid-depth. | Bottom. | | Surface. | | Mid-depth. | Bottom. | | Mid-depth. | Mid-depth. | |
| | Worcester Street Bridge. | Quinebog River. | Stillwater River. | Mid-depth. | Bottom. | Mid-depth. | Bottom. | End of Open Channel. | No. 2. | No. 3. | Surface. | Mid-depth. | Bottom. |
| January, | 14 | 14 | 14 | 51 | 61 | 51 | 15 | 15 | 15 | 37 | 85 | 15 | 25 |
| February, | 21 | 16 | 16 | 54 | 61 | 53 | 18 | 19 | 19 | 20 | 89 | 23 | 27 |
| March, | 28 | 25 | 23 | 54 | 57 | 53 | 25 | 26 | 25 | 63 | 74 | 28 | 45 |
| April, | 18 | 20 | 21 | 42 | 54 | 48 | 23 | 23 | 23 | 22 | 95 | 24 | 31 |
| May, | 15 | 15 | 16 | 39 | 48 | 42 | 17 | 17 | 17 | 18 | 109 | 17 | 24 |
| June, | 16 | 16 | 17 | 34 | 71 | 45 | 17 | 17 | 17 | 24 | 112 | 17 | 22 |
| July, | 16 | 16 | 17 | 30 | 38 | 39 | 17 | 17 | 17 | 17 | 89 | 17 | 23 |
| August, | 16 | 17 | 18 | 18 | 31 | 27 | 16 | 17 | 17 | 17 | 72 | 16 | 22 |
| September, | 15 | 15 | 17 | 16 | 30 | 28 | 15 | 16 | 21 | 16 | 62 | 16 | 18 |
| October, | 14 | 14 | 15 | 15 | 34 | 26 | 14 | 14 | 14 | 14 | 50 | 14 | 17 |
| November, | 14 | 14 | 14 | 15 | 38 | 35 | 15 | 15 | 15 | 15 | 50 | 15 | 16 |
| December, | 12 | 12 | 13 | 16 | 34 | 30 | 13 | 13 | 13 | 14 | 47 | 13 | 20 |
| Mean, | 17 | 16 | 17 | 32 | 46 | 40 | 17 | 17 | 18 | 23 | 78 | 18 | 26 |
| | | | | | | | | | | | | | 100 |
| | | | | | | | | | | | | | 77 |

¹ The colors given in this column represent the combined colors of the waters of the four principal feeders. The color of each is determined monthly, and due weight is given, in combining the results, to the sizes of the streams.

TABLE No. 35.—*Colors of Water, etc.*—Concluded.
[Platinum Standard.]

| MONTH. | CHESTNUT HILL RESERVOIR. | | | SPOT POND. | FELLS RESERVOIR. | NORTHERN SERVICE. | | SOUTHERN SERVICE. | |
|----------------------|---------------------------|------------------------------|----------------------------|------------|------------------|--|---|---|--|
| | Inlet (Sudbury Aqueduct). | Inlet (Cochituate Aqueduct). | Effluent Gate-house No. 2. | | | Tap at Glenwood Yard, Medford (Low Service). | Tap at Fire Station, Hancock Street, Everett, (High Service). | Tap at 244 Boylston Street, Boston (Low Service). | Tap at 1 Ashburton Place, Boston (High Service). |
| | | | | | | Mid-depth. | Effluent Gate-house. | | |
| January, | 15 | 15 | 12 | | | 14 | 12 | 15 | 15 |
| February, | 21 | 21 | 15 | | | 22 | 15 | 21 | 22 |
| March, | 26 | 26 | 16 | | | 26 | 16 | 27 | 27 |
| April, | 24 | 21 | 12 | | | 24 | 13 | 22 | 22 |
| May, | 18 | 17 | 9 | | | 17 | 10 | 17 | 17 |
| June, | 17 | 17 | 10 | | | 17 | 10 | 17 | 17 |
| July, | 17 | 17 | 10 | | | 17 | 10 | 17 | 17 |
| August, | 17 | 17 | 12 | | | 17 | 12 | 17 | 17 |
| September, | 15 | 15 | 12 | | | 16 | 12 | 16 | 17 |
| October, | 15 | 15 | 11 | | | 14 | 11 | 15 | 15 |
| November, | 14 | 14 | 12 | | | 14 | 12 | 14 | 14 |
| December, | 13 | 13 | 10 | | | 10 | 10 | 13 | 13 |
| Mean, | 18 | — | 12 | | | 12 | 12 | 18 | 18 |

TABLE No. 36.—*Temperatures of Water from Various Parts of the Metropolitan Water Works in 1910. (Means of Weekly Determinations.)*

[The temperatures are taken at the same places and times as the samples for microscopical examination; the depth given for each reservoir is the depth from high water mark.]

[Degrees Fahrenheit.]

| MONTH. | WACHUSSETT RESERVOIR. | | | SUDSBURY RESERVOIR (DEPTH AT PLACE OF OBSERVATION 54.5 FEET). | | | FRAMINGHAM RESERVOIR NO. 3 (DEPTH AT PLACE OF OBSERVATION 20.5 FEET). | | | LAKE COCHITUATE (DEPTH AT PLACE OF OBSERVATION 62.0 FEET). | | | |
|----------------------|-----------------------|------------|---------|---|------------|---------|---|------------|---------|--|------------|---------|------|
| | Surface. | Mid-depth. | Bottom. | Surface. | Mid-depth. | Bottom. | Surface. | Mid-depth. | Bottom. | Surface. | Mid-depth. | Bottom. | |
| | | | | | | | | | | | | | |
| January, | 33.8 | 34.3 | 34.8 | 33.4 | 34.8 | 35.5 | 34.3 | 33.5 | 33.7 | 34.2 | 34.9 | 37.2 | 37.5 |
| February, | 34.0 | 35.0 | 35.5 | 33.3 | 36.1 | 37.4 | 35.0 | 34.1 | 34.7 | 34.3 | 33.4 | 35.5 | 36.1 |
| March, | 36.0 | 36.8 | 38.0 | 38.5 | 39.0 | 39.3 | 37.3 | 39.1 | 39.2 | 39.4 | 38.0 | 39.0 | 38.8 |
| April, | 45.0 | 43.8 | 44.3 | 50.9 | 49.6 | 48.8 | 46.5 | 52.1 | 51.9 | 51.5 | 49.5 | 47.0 | 45.0 |
| May, | 54.6 | 51.4 | 49.6 | 58.3 | 57.4 | 56.4 | 52.1 | 61.1 | 60.2 | 59.5 | 59.4 | 51.4 | 48.9 |
| June, | 65.5 | 55.8 | 51.8 | 66.8 | 62.9 | 61.3 | 56.4 | 69.5 | 69.0 | 66.7 | 66.6 | 53.0 | 47.1 |
| July, | 75.0 | 56.7 | 53.7 | 74.6 | 69.0 | 64.9 | 59.5 | 77.1 | 76.7 | 76.0 | 77.0 | 53.5 | 49.0 |
| August, | 71.5 | 57.0 | 53.8 | 71.9 | 68.3 | 65.2 | 57.6 | 73.3 | 73.0 | 72.9 | 72.8 | 53.8 | 44.8 |
| September, | 70.0 | 64.0 | 54.0 | 66.8 | 65.4 | 64.3 | 58.0 | 67.1 | 64.5 | 67.0 | 68.3 | 53.0 | 45.9 |
| October, | 60.0 | 59.5 | 55.8 | 60.1 | 62.0 | 59.0 | 57.1 | 58.0 | 57.7 | 57.9 | 59.8 | 55.5 | 46.0 |
| November, | 48.0 | 47.8 | 47.6 | 45.5 | 45.7 | 46.8 | 45.1 | 42.8 | 42.0 | 42.7 | 45.4 | 46.8 | 44.2 |
| December, | 34.8 | 35.5 | 36.0 | 34.5 | 35.1 | 36.3 | 35.0 | 34.9 | 35.3 | 35.0 | 37.3 | 37.3 | 39.5 |
| Mean, | 52.4 | 48.1 | 46.2 | 52.9 | 52.1 | 51.3 | 47.8 | 53.6 | 53.2 | 53.1 | 53.4 | 46.9 | 43.6 |

TABLE No. 36.—*Concluded.*

[Degrees Fahrenheit.]

| MONTH. | CHESTNUT HILL RESERVOIR. | SPOT POND (DEPTH AT PLACE OF OBSERVATION 28.0 FEET). | | | NORTHERN SERVICE. | SOUTHERN SERVICE. |
|----------------------|--------------------------------|--|------------|---------|----------------------|----------------------|
| | | Surface. | Mid-depth. | Bottom. | | |
| January, | 37.0 | 34.8 | 34.9 | 35.6 | 39.3 | 38.0 |
| February, | 36.9 | 35.6 | 35.6 | 36.1 | 39.4 | 39.3 |
| March, | 41.5 | 38.9 | 39.4 | 39.5 | 41.4 | 41.3 |
| April, | 51.2 | 49.8 | 49.8 | 49.5 | 51.3 | 54.0 |
| May, | 58.1 | 57.8 | 57.7 | 56.8 | 57.7 | 59.4 |
| June, | 64.4 | 65.1 | 64.1 | 62.1 | 63.8 | 64.3 |
| July, | 77.6 | 75.3 | 74.6 | 66.5 | 73.4 | 73.6 |
| August, | 73.4 | 73.0 | 72.9 | 71.3 | 72.9 | 73.1 |
| September, | 67.6 | 68.1 | 67.3 | 67.0 | 67.3 | 67.0 |
| October, | 61.0 | 59.5 | 59.5 | 59.6 | 61.6 | 59.9 |
| November, | 44.2 | 45.5 | 45.6 | 45.9 | 51.4 | 47.2 |
| December, | 36.5 | 35.6 | 35.8 | 35.8 | 42.0 | 37.5 |
| Mean, | 54.1 | 53.3 | 52.8 | 52.2 | 55.1 | 54.2 |

*ARTHUR C. BULLARD,
C.*

TABLE No. 37.—*Temperatures of the Air at Three Stations on the Metropolitan Water Works in 1910.*

[Degrees Fahrenheit.]

| MONTH. | CHESTNUT HILL RESERVOIR. | | | FRAMINGHAM. | | | CLINTON. | | |
|----------------------|-----------------------------|----------|-------|-------------|----------|-------|----------|----------|-------|
| | Maximum. | Minimum. | Mean. | Maximum. | Minimum. | Mean. | Maximum. | Minimum. | Mean. |
| January, | 56.0 | -6.0 | 29.3 | 55.0 | -12.0 | 27.8 | 51.0 | -12.0 | 26.5 |
| February, | 59.0 | -5.0 | 28.7 | 56.0 | -7.0 | 27.2 | 53.0 | -8.0 | 23.4 |
| March, | 78.0 | 14.0 | 41.8 | 77.0 | 12.0 | 41.7 | 77.0 | 12.0 | 39.2 |
| April, | 79.0 | 27.0 | 52.6 | 77.0 | 25.0 | 52.4 | 77.0 | 26.0 | 50.7 |
| May, | 89.0 | 34.0 | 58.3 | 87.0 | 32.0 | 57.6 | 82.0 | 36.0 | 56.2 |
| June, | 92.0 | 37.0 | 64.9 | 90.0 | 35.0 | 64.6 | 85.0 | 37.0 | 63.3 |
| July, | 95.0 | 52.0 | 74.4 | 96.0 | 50.0 | 73.2 | 92.0 | 52.0 | 71.7 |
| August, | 91.0 | 44.0 | 69.4 | 87.0 | 41.0 | 67.5 | 82.0 | 46.0 | 66.6 |
| September, | 84.0 | 37.0 | 63.5 | 82.0 | 32.0 | 62.7 | 80.0 | 40.0 | 60.3 |
| October, | 87.0 | 22.0 | 55.5 | 84.0 | 20.0 | 54.4 | 80.0 | 24.0 | 52.2 |
| November, | 62.0 | 19.0 | 39.3 | 60.0 | 15.0 | 38.3 | 58.0 | 19.0 | 37.9 |
| December, | 54.0 | 1.0 | 26.3 | 51.0 | -2.0 | 24.6 | 49.0 | 2.0 | 23.8 |
| Average, | - | - | 50.3 | - | - | 49.3 | - | - | 47.7 |

TABLE No. 38.—Table showing Length of Main Lines of Water Pipes and Connections owned and operated by Metropolitan Water and Sewerage Board, and Number of Valves set in Same, Dec. 31, 1910.

| | DIAMETER OF PIPES IN INCHES. | | | | | | | | | | Total. | | | | | | |
|--|------------------------------|---------|--------|---------------------|---------|--------|--------|--------|--------|--------|--------|-------|--------|---------|-------|--------|----------------------|
| | 60 | 48 | 42 | 36 | 30 | 24 | 20 | 16 | 14 | 12 | 10 | 8 | 6 | | | | |
| Total length owned and operated Jan. 1, 1910 (feet), | 14,418 | 184,531 | 8,075 | 46,915 | 26,927 | 59,004 | 57,272 | 59,082 | 26 | 26,028 | 3,751 | 1,575 | 929 | 488,533 | | | |
| Gate valves in same, | - | - | 49 | - | 44 | 28 | 42 | 39 | 70 | 1 | 82 | 17 | 13 | 19 | 404 | | |
| Air valves in same, | - | - | 9 | 111 | 3 | 35 | 5 | 26 | 34 | 30 | - | 10 | 1 | - | 264 | | |
| Length laid or relaid during 1910 (feet), | - | - | 12,234 | 1,540 | - | 3,470 | 754 | 355 | 98 | 8,516 | - | 313 | 12 | 286 | 4 | 27,591 | |
| Gate valves in same, | - | - | - | 2 | - | - | 2 | 1 | 7 | 3 | 1 | - | 11 | - | 2 | 1 | 30 |
| Air valves in same, | - | - | - | 13 | - | - | 3 | 1 | 3 | - | 3 | - | - | - | - | - | 23 |
| Length abandoned during 1910 (feet), | - | - | - | 3,419 | - | 38 | - | 2 | 59 | 16 | - | 276 | 16 | 36 | 20 | 3,882 | |
| Gate valves in same, | - | - | - | - | - | - | - | - | 1 | - | - | 2 | - | 1 | 1 | 1 | 5 |
| Air valves in same, | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Length owned and operated Jan. 1, 1911 (feet), | - | - | - | 26,652 ¹ | 182,661 | 8,075 | 50,347 | 27,681 | 59,357 | 57,311 | 67,582 | 26 | 26,065 | 3,747 | 1,825 | 913 | 512,242 ² |
| Gate valves in same, | - | - | - | 2 | 49 | - | 46 | 29 | 49 | 41 | 71 | 1 | 91 | 17 | 14 | 19 | 429 |
| Air valves in same, | - | - | - | 22 | 111 | 3 | 38 | 6 | 29 | 34 | 33 | - | 10 | 1 | - | - | 287 |

¹ Includes 17,588 feet of 60-inch, 3,357 feet of 36-inch and 730 feet of 30-inch pipe laid but not yet used.

² 97.02 miles.
This table does not include 10 feet of 48-inch and 292 feet of 36-inch pipe laid as temporary line in Harvard Square, Cambridge.

TABLE No. 39.—*Statement of Cast-iron Hydrant, Blow-off and Drain Pipes, owned and operated by Metropolitan Water and Sewerage Board, Dec. 31, 1910.*

METROPOLITAN WATER

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TABLE No. 40.—Length of Water Pipes, Four Inches in Diameter and Larger, in the Several Cities and Towns supplied by the Metropolitan Water Works, Dec. 31, 1910.

| By whom owned. | INCHES. | | | | | | | | | | | | TOTAL. | |
|--|---------|---------|--------|--------|--------|---------|--------|---------|---------|--------|---------|---------|-----------|-----------|
| | 60 | 48 | 42 | 40 | 36 | 30 | 28 | 24 | 20 | 18 | 16 | 14 | Feet. | Miles. |
| Metropolitan Water Works, | 26,652 | 182,661 | 8,075 | 50,347 | 59,357 | 57,311 | — | 67,582 | 26 | 26,065 | 3,747 | 1,825 | 913 | — |
| Boston, Somerville, Malden, Chelsea, Everett, Quincy, Medford, Melrose, Revere, Watertown, Arlington, Milton, Winthrop, Stoneham, Belmont, Lexington, Nahant, Swampscott, | 39,175 | 16,813 | 23,104 | 44,804 | 98,937 | 244 | 77,382 | 217,198 | 8,037 | 63,032 | 51,181 | 655,574 | 1,254,094 | 512,242 |
| | 3,596 | 367 | — | — | — | — | 9,152 | — | 64,834 | 27,595 | 77,603 | — | 202,574 | 4,041,293 |
| | — | — | — | — | — | — | 5,176 | — | 4,974 | 39,820 | 27,610 | — | 212,787 | 765,40 |
| | 2,484 | — | — | — | — | — | 2,233 | — | 5,570 | 39,502 | 22,031 | — | 135,936 | 89,47 |
| | 2,900 | — | — | — | — | — | 23,232 | — | 26,654 | 37,534 | 984 | — | 137,236 | 452,712 |
| | 2,679 | — | — | — | — | — | 673 | 6,775 | 9,598 | 26,452 | 37,738 | 73,161 | — | 243,362 |
| | 673 | — | — | — | — | — | 5,223 | 2,920 | 22,986 | 19,016 | 24,249 | — | 130,405 | 45,948 |
| | — | — | — | — | — | — | 22,650 | 5,700 | 19,280 | 14,550 | 17,503 | — | 56,750 | 283,305 |
| | — | — | — | — | — | — | 400 | 11,877 | 5,859 | 4,644 | 19,861 | — | 120,206 | 211,984 |
| | — | — | — | — | — | — | — | — | — | — | — | — | 175,613 | 33,26 |
| | — | — | — | — | — | — | 31,804 | — | 21,621 | 32,742 | — | — | 22,602 | 126,286 |
| | — | — | — | — | — | — | 103 | 44 | 22,548 | 20,935 | 50,860 | — | 122,999 | 38,50 |
| | — | — | — | — | — | — | — | — | 4,049 | 23,297 | 30,339 | — | 35,935 | 44,22 |
| | — | — | — | — | — | — | — | — | — | 4,525 | 4,725 | 94,189 | 62,531 | 156,151 |
| | — | — | — | — | — | — | — | — | — | — | — | — | 134,438 | 29,57 |
| | — | — | — | — | — | — | — | — | — | — | — | — | 120,652 | 22,85 |
| | — | — | — | — | — | — | — | — | — | — | — | — | 114,532 | — |
| | — | — | — | — | — | — | — | — | — | — | — | — | 135,724 | 21,69 |
| | — | — | — | — | — | — | — | — | — | — | — | — | 108,500 | 25,70 |
| | — | — | — | — | — | — | — | — | — | — | — | — | 98,087 | 20,55 |
| | — | — | — | — | — | — | — | — | — | — | — | — | — | 18,58 |
| Total feet, | 26,652 | 221,836 | 24,888 | 23,194 | 95,151 | 126,618 | 244 | 139,323 | 162,176 | 367 | 354,019 | 48,180 | 1,625,756 | 994 |
| Total miles, | 5.05 | 42.01 | 4.71 | 4.38 | 18.01 | 23.98 | 0.05 | 26.39 | 30.71 | 0.07 | 67.05 | 9.12 | 307.91 | 110.72 |
| | | | | | | | | | | | | | 243.14 | 0.19 |
| | | | | | | | | | | | | | 610.89 | 0.18 |
| | | | | | | | | | | | | | 128.81 | — |
| | | | | | | | | | | | | | — | 1,633.37 |

¹ Includes small portion of Saugus.

TABLE No. 41.—*Number of Service Pipes, Meters and Fire Hydrants in the Several Cities and Towns supplied by the Metropolitan Water Works, Dec. 31, 1910, and the Number of Services and Meters installed during the Year 1910.*

| CITY OR TOWN. | Services. | Meters. | Fire Hydrants. | Services Installed. | Meters Installed. |
|--------------------------------|-----------|---------|----------------|---------------------|-------------------|
| Boston, | 93,780 | 18,720 | 8,406 | 1,134 | 6,615 |
| Somerville, | 12,149 | 5,810 | 1,065 | 149 | 728 |
| Malden, | 7,440 | 7,163 | 440 | 161 | 185 |
| Chelsea, | 4,790 | 3,082 | 346 | 105 | 884 |
| Everett, | 5,380 | 1,186 | 528 | 62 | 354 |
| Quincy, | 7,307 | 2,634 | 808 | 493 | 602 |
| Medford, | 4,550 | 4,296 | 545 | 149 | 1,704 |
| Melrose, | 3,583 | 3,777 | 320 | 79 | 270 |
| Revere, ¹ | 3,454 | 891 | 183 | 188 | 295 |
| Watertown, | 2,042 | 2,070 | 341 | 69 | 97 |
| Arlington, | 2,050 | 1,288 | 398 | 83 | 167 |
| Milton, | 1,454 | 1,454 | 356 | 74 | 74 |
| Winthrop, | 2,487 | 2,386 | 207 | 167 | 873 |
| Stoneham, | 1,467 | 635 | 112 | 21 | 207 |
| Belmont, | 909 | 909 | 177 | 63 | 63 |
| Lexington, | 836 | 475 | 138 | 57 | 113 |
| Nahant, | 532 | 227 | 81 | 20 | 48 |
| Swampscott, | 1,478 | 1,465 | 142 | 82 | 110 |
| Total, | 156,688 | 58,468 | 14,593 | 3,156 | 13,389 |

¹ Includes small portion of Saugus.

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TABLE No. 42.—Average Maximum and Minimum Monthly Heights, in Feet, above Boston City Base, to which Water rose at Different Stations on the Metropolitan Water Works in 1910.

| Month. | LOW SERVICE. | | | SOUTHERN HIGH SERVICE. | | |
|--------------|--|---|----------------------------------|---|--|---------------------------------------|
| | BOSTON ENGINE HOUSE, BULFINCH STREET. | ALL-STON ENGINE HOUSE, HARVARD STREET. | MEDFORD, MYSTIC RESERVOIR. | SOMERVILLE CITY HALL ANNEX, WALNUT STREET. | MALDEN WATER WORKS SHOP, GREEN STREET. | WATER-TOWN CHELSEA COURT HOUSE. |
| | Maximum. | Minimum. | Maximum. | Minimum. | Maximum. | Minimum. |
| January, . | 136 | 126 | 163 | 167 | 163 | 168 |
| February, . | 134 | 124 | 180 | 170 | 164 | 167 |
| March, . | 136 | 129 | 180 | 171 | 168 | 164 |
| April, . | 141 | 126 | 178 | 170 | 168 | 165 |
| May, . | 151 | 129 | 188 | 179 | 180 | 171 |
| June, . | 149 | 129 | 181 | 172 | 168 | 164 |
| July, . | 142 | 128 | 183 | 176 | 167 | 163 |
| August, . | 144 | 128 | 184 | 175 | 167 | 164 |
| September, . | 143 | 130 | 182 | 172 | 168 | 164 |
| October, . | 150 | 129 | 188 | 181 | 167 | 163 |
| November, . | 152 | 129 | 195 | 192 | 166 | 161 |
| December, . | 134 | 125 | 184 | 175 | 167 | 164 |
| Averages, . | 143 | 128 | 184 | 175 | 168 | 164 |

TABLE No. 42.—Average Maximum and Minimum Monthly Heights, in Feet, above Boston City Base, &c.—Concluded.

| MONTH. | SOUTHERN HIGH-SERVICE — Concluded. | | | NORTHERN HIGH-SERVICE. | | | NORTHERN EXTRA HIGH-SERVICE. | | |
|------------|---|---|----------------------------------|--|----------------------|---|--|---|--|
| | BELMONT WATER WORKS SHOP, WAYER- LEY STREET. | MILTON WATER WORKS OFFICE, ADAMS STREET. | FORBES HILL TOWER, QUINCY. | SOMERVILLE PUMPING STA- TION, CEDAR STREET. | MALDEN CITY HALL. | REVERE WATER WORKS OFFICE, BROADWAY. | LYNN ENGINE HOUSE, UNION SQUARE. | WINTHROP TOWN HALL, HERMAN STREET. | LEXINGTON TOWN HALL, MASSA- CHUSETTS AVENUE. |
| | Maximum. | Minimum. | Maximum. | Maximum. | Minimum. | Maximum. | Minimum. | Maximum. | Minimum. |
| January, | 263 | 254 | 247 | 239 | 231 | 237 | 221 | 270 | 255 |
| February, | 263 | 254 | 246 | 238 | 237 | 230 | 219 | 270 | 257 |
| March, | 263 | 252 | 246 | 236 | 237 | 230 | 219 | 270 | 256 |
| April, | 262 | 250 | 247 | 236 | 238 | 228 | 217 | 269 | 253 |
| May, | 262 | 249 | 246 | 234 | 236 | 226 | 215 | 270 | 250 |
| June, | 262 | 249 | 245 | 235 | 224 | 234 | 211 | 268 | 249 |
| July, | 262 | 238 | 246 | 231 | 234 | 219 | 232 | 200 | 268 |
| August, | 262 | 241 | 245 | 234 | 235 | 222 | 204 | 267 | 249 |
| September, | 263 | 251 | 246 | 235 | 236 | 225 | 209 | 268 | 250 |
| October, | 263 | 249 | 247 | 233 | 239 | 226 | 237 | 210 | 269 |
| November, | 263 | 251 | 248 | 233 | 238 | 230 | 211 | 270 | 253 |
| December, | 262 | 253 | 245 | 234 | 238 | 230 | 236 | 212 | 269 |
| Averages, | 263 | 249 | 246 | 235 | 237 | 227 | 236 | 212 | 251 |

APPENDIX No. 3.

WATER WORKS STATISTICS FOR THE YEAR 1910.

The Metropolitan Water Works supply the Metropolitan Water District, which includes the following cities and towns:—

| CITY OR TOWN. | Population, Census of 1910. | Estimated Population, July 1, 1910. |
|--|--------------------------------|---|
| Boston, | 670,585 | 674,400 |
| Somerville, | 77,236 | 77,640 |
| Malden, | 44,404 | 44,730 |
| Chelsea, | 32,452 | 32,540 |
| Newton, ¹ | 39,806 | 39,960 |
| Everett, | 33,484 | 33,710 |
| Quincy, | 32,642 | 32,870 |
| Medford, | 23,150 | 23,330 |
| Hyde Park, ¹ | 15,507 | 15,560 |
| Melrose, | 15,715 | 15,790 |
| Revere, | 18,219 | 18,500 |
| Watertown, | 12,875 | 12,960 |
| Arlington, | 11,187 | 11,270 |
| Milton, | 7,924 | 7,970 |
| Winthrop, | 10,132 | 10,290 |
| Stoneham, | 7,090 | 7,130 |
| Swampscott, | 6,204 | 6,260 |
| Lexington, | 4,918 | 4,940 |
| Belmont, | 5,542 | 5,600 |
| Nahant, | 1,184 | 1,200 |
| ! Total population of Metropolitan Water District, | 1,070,256 | 1,076,650 |
| Saugus, ² | 280 | 280 |

¹ No water supplied to these places during the year from Metropolitan Water Works.

² Only a small portion of Saugus is supplied with water.

Mode of Supply.

26 per cent. by gravity.

74 per cent. by pumping.

*Pumping.**Chestnut Hill High-service Station: —*

Builders of pumping machinery, Holly Manufacturing Company, Quintard Iron Works and E. P. Allis Company.

Description of coal used: — Bituminous: Beaver Run, Nan-ty-glo, and Vulcan. Anthracite: buckwheat. Price per gross ton in bins: bituminous \$3.96 to \$4.09, buckwheat \$2.75 to \$2.80. Average price per gross ton \$3.70. Per cent. ashes, 11.0.

Chestnut Hill Low-service Station: —

Builders of pumping machinery, Holly Manufacturing Company.

Description of coal used: — Bituminous: Vulcan, Beaver Run. Anthracite: buckwheat. Price per gross ton in bins: bituminous \$3.79 to \$4.01, buckwheat \$2.58 to \$2.62. Average price per gross ton \$3.46. Per cent. ashes, 10.6.

Spot Pond Station: —

Builders of pumping machinery, Geo. F. Blake Manufacturing Company and Holly Manufacturing Company.

Description of coal used: — Bituminous: Davis, Georges Creek and New River. Anthracite: screenings. Price per gross ton in bins: bituminous \$4.60 to \$4.88, screenings \$2.50. Average price per gross ton \$4.29. Per cent. ashes, 12.9.

| | CHESTNUT HILL HIGH-SERVICE STATION. | Engines Nos. 1 and 2. | Engine No. 3. | Engine No. 4. |
|---|-------------------------------------|-----------------------|---------------|---------------|
| Daily pumping capacity (gallons), | 16,000,000 | 20,000,000 | 30,000,000 | |
| Coal consumed for year (pounds), | 2,168,024 | 247,119 | 8,467,877 | |
| Cost of pumping, figured on pumping station expenses, | \$8,114.83 | \$1,014.59 | \$33,239.02 | |
| Total pumpage for year, corrected for slip (million gallons), | 1,377.71 | 228.67 | 10,824.70 | |
| Average dynamic head (feet), | 119.67 | 129.88 | 130.58 | |
| Gallons pumped per pound of coal, | 635.47 | 925.34 | 1,278.33 | |
| Duty on basis of plunger displacement, | 65,310,000 | 104,710,000 | 141,840,000 | |
| Cost per million gallons raised to reservoir, | \$5.890 | \$4.437 | \$3.071 | |
| Cost per million gallons raised one foot, | .0492 | .0342 | .0235 | |

| | CHESTNUT HILL LOW-SERVICE STATION. | SPOT POND STATION. |
|---|------------------------------------|-----------------------|
| | Engines Nos. 5, 6 and 7. | Engines Nos. 8 and 9. |
| Daily pumping capacity (gallons), | 105,000,000 | 30,000,000 |
| Coal consumed for year (pounds), | 7,122,390 | 2,413,914 |
| Cost of pumping, figured on pumping station expenses, | \$32,990.07 | \$13,622.47 |
| Total pumpage for year, corrected for slip (million gallons), | 18,394.52 | 2,752.11 |
| Average dynamic head (feet), | 49.08 | 130.92 |
| Gallons pumped per pound of coal, | 2,582.63 | 1,140.10 |
| Duty on basis of plunger displacement, | 107,750,000 | 126,860,000 |
| Cost per million gallons raised to reservoir, | \$1.793 | \$4.950 |
| Cost per million gallons raised one foot, | .0365 | .0378 |

Consumption.

| | |
|--|----------------|
| Estimated total population of the nineteen cities and towns supplied wholly or partially during the year 1910, | 1,022,230 |
| Total consumption (gallons), pump basis, | 41,539,100,000 |
| Average daily consumption (gallons), pump basis, | 113,806,000 |
| Gallons per day to each inhabitant, pump basis, | 111.3 |

Distribution.

| | Owned and operated by Metropolitan Water and Sewerage Board. | Total in District supplied by Metropolitan Water Works. |
|--|---|--|
| Kinds of pipe used, | -1 | -2 |
| Sizes, | 60 to 6 inch. | 60 to 4 inch. |
| Extensions, less length abandoned (miles), | 4.49 | 30.75 |
| Length in use (miles), | 97.02 | 1,633.37 |
| Stop gates added, | 25 | - |
| Stop gates now in use, | 429 | - |
| Service pipes added, | - | 3,156 |
| Service pipes now in use, | - | 155,636 |
| Meters added, | - | 13,389 |
| Meters now in use, | - | 58,462 |
| Fire hydrants added, | - | 238 |
| Fire hydrants now in use, | - | 14,593 |

¹ Cast-iron and cement-lined wrought iron.

² Cast-iron, cement-lined wrought iron and kalamine.

APPENDIX NO. 4.

CONTRACTS MADE AND PENDING DURING

Contracts relating to the

| 1. Number of Con- tract. | 2. WORK. | 3. Num- ber of Bids. | AMOUNT OF BID. | | 6. Contractor. |
|-----------------------------------|---|----------------------------------|---|--|--|
| | | | 4. Next to Lowest. | 5. Lowest. | |
| 1 68 | Additions to the pumping plant at Deer Island, Boston Harbor. | 4 | \$69,230 00 ² | \$51,990 00 | Allis-Chalmers Co., Milwaukee, Wis. |
| 2 73 | Additions to the pumping plant at East Boston. | 1 | - | 37,000 00 ² | Allis-Chalmers Co., Milwaukee, Wis. |
| 3 74 | Extension and repair of engine, boiler and screen-houses and new coal house at East Boston. | 6 | 123,722 00 | 110,940 00 ² | Woodbury & Leigh-ton Co., Boston. |
| 4 75 ¹ | 2,950 tons of coal:— 2,500 tons for East Boston pumping station. 450 tons for Alewife Brook pumping station. | 6 { 3 { | \$3.96 per ton. \$4.30 per ton. | \$3.69 per ton. ² \$4.25 per ton. ² | New England Coal and Coke Co., Boston. |
| 5 76 ¹ | 3,050 tons of coal:— 2,100 tons for Deer Island pumping station. 950 tons for Charlestown pumping station. | 7 { 6 { | \$3.85 per ton. \$3.65 per ton. | \$3.74 per ton. ² \$3.64 per ton. ² | Staples Coal Co., Bos-ton. |
| 6 78 ¹ | Additions to the boiler plant at East Boston pumping station. | 6 | \$31,933 00 ² | \$29,000 00 | Robb-Mumford Boiler Co., South Framing-ham. |
| 7 79 ¹ | Two sets of screens for the Deer Island pumping sta-tion. | 2 | 5,994 00 | 5,800 00 ² | Hyde Windlass Co., Bath, Me. |
| 8 80 ¹ | Pile wharf, steel floor beams, braces and coal runs at the East Boston pumping sta-tion. | 8 | 9,498 00 | 8,475 00 ² | John T. Scully Foun-dation and Trans-portation Company, Cambridge. |
| 9 82 | 4,400 tons of coal:— 3,000 tons for East Boston pumping station. 1,000 tons for Charlestown pumping station. 400 tons for Alewife Brook pumping station. | 6 { 3 { 2 { | \$4.12 per ton. \$4.09 per ton. \$4.85 per ton. | \$4.10 per ton. ² \$3.90 per ton. ² \$4.55 per ton. ² | New England Coal and Coke Co., Boston. |
| 10 83 | 2,600 tons of coal for Deer Island pumping station. | 3 | \$4.22 per ton. | \$4.20 per ton. ² | Metropolitan Coal Co., Boston. |

¹ Contract completed.² Contract based upon this bid.

APPENDIX No. 4.

THE YEAR 1910 — SEWERAGE WORKS.

North Metropolitan System.

| 7. Date of Con- tract. | 8. Date of Completion of Work. | 9. Prices of Principal Items of Contracts made in 1910. | 10. Value of Work done Dec. 31, 1910. | |
|------------------------------|---|--|--|----|
| Nov. 2, 1908 | - | - | \$62,307 00 | 1 |
| June 5, 1909 | - | - | 18,500 00 | 2 |
| Aug. 13, 1909 | - | - | 114,934 71 ^a | 3 |
| June 18, 1909 | June 1, 1910 | - | 11,662 77 | 4 |
| June 25, 1909 | June 1, 1910 | - | 12,442 46 | 5 |
| Dec. 15, 1909 | Dec. 12, 1910 | - | 31,933 00 | 6 |
| May 16, 1910 | Aug. 20, 1910 | For furnishing and delivering two sets of screens for the Deer Island pumping station on the Deer Island wharf in condition for erection. | 5,600 00 | 7 |
| July 15, 1910 | Dec. 23, 1910 | For furnishing and erecting pile wharf, steel floor beams, braces and coal runs for the East Boston pumping station. | 8,618 91 | 8 |
| July 25, 1910 | - | \$4.10 per ton of 2,240 lbs. delivered in bins at East Boston pumping station. \$3.90 per ton of 2,240 lbs. delivered in bins at Charlestown pumping station. \$4.55 per ton of 2,240 lbs. delivered in bins at Alewife Brook pumping station. | 9,445 84 | 9 |
| July 25, 1910 | - | \$4.20 per ton of 2,240 lbs. delivered in bins at Deer Island pumping station. | 6,238 92 | 10 |

^a \$17,284.43 charged to special maintenance fund.

CONTRACTS MADE AND PENDING DURING THE

Contracts relating to the South

| 1. Number of Con- tract. | 2. WORK. | 3. Num- ber of Bids. | AMOUNT OF BID. | | 6. Contractor. |
|-----------------------------------|--|----------------------------------|--|--|---|
| | | | 4. Next to Lowest. | 5. Lowest. | |
| 1 76 ¹ | 2,500 tons of coal:— 2,100 tons for Ward Street pumping station. 400 tons for Nut Island screen-house. | { 6 { 7 } | \$4.14 per ton. \$4.10 per ton. | \$4.09 per ton. ² \$3.74 per ton. ² | Staples Coal Co., Bos- ton. |
| 2 77 ¹ | 400 tons of coal for Quincy pumping station. | 3 | \$4.40 per ton. | \$4.15 per ton. ² | Neponset River Coal Co., Dorchester. |
| 3 83 | 500 tons of coal for Nut Island screen-house. | 4 | \$4.24 per ton. | \$4.20 per ton. ² | Metropolitan Coal Co., Boston. |
| 4 84 | 2,300 tons of coal for Ward Street pumping station. | 3 | \$4.45 per ton. | \$4.29 per ton. ² | Staples Coal Co., Bos- ton. |
| 5 85 | 400 tons of coal for Quincy pumping station. | 3 | \$4.80 per ton. | \$4.50 per ton. ² | Frost Coal Co., Dor- chester. |
| 6 87 | Receiving basin, founda- tions and appurtenances for sewage lift station, Hough's Neck, Quincy. | 8 | \$10,800 00 | \$9,371 00 ² | John Cashman & Sons Company, Quincy. |
| 7 88 | Sewage lift station building, Hough's Neck, Quincy. | 6 | 1,760 00 | 1,725 00 ² | C. A. Dodge Company, Cambridge. |

¹ Contract completed.² Contract based upon this bid.

YEAR 1910—SEWERAGE WORKS—*Continued.**Metropolitan System.*

| 7. Date of Con- tract. | 8. Date of Completion of Work. | 9. Prices of Principal Items of Contracts made in 1910. | 10. Value of Work done Dec. 31, 1910. | |
|------------------------------|---|---|--|---|
| June 25, 1909 | June 1, 1910 | — | \$8,756 01 | 1 |
| June 30, 1909 | June 1, 1910 | — | 1,531 01 | 2 |
| July 25, 1910 | — | \$4.20 per ton of 2,240 lbs. delivered in bins at Nut Island screen-house. | 810 00 | 3 |
| July 25, 1910 | — | \$4.29 per ton of 2,240 lbs. delivered in bins at Ward Street pumping station. | 1,713 17 | 4 |
| July 25, 1910 | — | \$4.50 per ton of 2,240 lbs. delivered in bins at Quincy pumping station. | 299 19 | 5 |
| Aug. 29, 1910 | — | For earth excavation and refilling in receiving basin, pump well, pipe and conduit trenches and grading lot, including manholes, laying of pipe, etc., the sum of \$2,271; for Portland cement brick masonry in manholes, \$16 per cu. yd.; for Portland cement concrete masonry, \$9 per cu. yd. | 3,465 50 | 6 |
| Nov. 14, 1910 | — | For brick sewage lift station building, | — | 7 |

CONTRACTS MADE AND PENDING DURING THE YEAR 1910 — SEWERAGE WORKS
— *Concluded.***Summary of Contracts.¹**

| | Value of Work done Dec. 31, 1910. |
|--|---|
| North Metropolitan System, 10 contracts, | \$281,683 61 |
| South Metropolitan System, 7 contracts, | 16,574 88 |
| Total of 17 contracts made and pending during the year 1910, | \$298,258 49 |

¹ In this summary the cost of day work and contracts charged to maintenance are excluded.

APPENDIX No. 5.

FINANCIAL STATEMENT PRESENTED TO THE GENERAL COURT ON JANUARY 9, 1911.

The Metropolitan Water and Sewerage Board respectfully presents the following abstract of the account of its doings, receipts, expenditures, disbursements, assets and liabilities for the year ending November 30, 1910, in accordance with the provisions of chapter 235 of the Acts of the year 1906.

METROPOLITAN WATER WORKS.

Construction.

The loans authorized for expenditures under the Metropolitan Water acts, the receipts which are added to the loan fund, the expenditures for the construction and acquisition of works, and the balance available on December 1, 1910, have been as follows:—

| | |
|---|-----------------|
| Loans authorized under Metropolitan Water acts, | \$41,878,000 00 |
| Receipt from town of Swampscott for admission to Metropolitan Water District, paid into Loan Fund (St. 1909, c. 320), | 90,000 00 |
| Receipts from the sales of property which are placed to the credit of the Metropolitan Water Loan Fund:— | |
| For the year ending November 30, 1910, | \$8,727 94 |
| For the period prior to December 1, 1909, | 167,051 56 |
| | 175,779 50 |
| | \$42,143,779 50 |
| Vmount approved for payment by the Board out of the Metropolitan Water Loan Fund:— | |
| For the year ending November 30, 1910, | \$478,791 51 |
| For the period prior to December 1, 1909, | 41,000,955 40 |
| | 41,479,746 91 |
| Balance December 1, 1910, | \$664,032 59 |

The amount of the Metropolitan Water Loan bonds issued and outstanding at the beginning of the fiscal year was \$10,898,000. At the end of the year the amount of the loans was \$41,398,000. The Metropolitan Water Loan Sinking Fund amounted at the beginning of the year to \$7,203,406.48, and at the end of the year to \$8,070,383.46. The net decrease in the debt for the Metropolitan Water Works was \$366,976.98.

Maintenance.

| | |
|---|--------------|
| Amount appropriated for the maintenance and operation of works for the year ending November 30, 1910, | \$414,000 00 |
| Balance of special appropriation for the improvement of the Cochituate watershed (1909), remaining, | 29,576 10 |
| Amount appropriated for the improvement of the Cochituate watershed, additional, | 6,000 00 |
| | <hr/> |
| Amount approved by the Board for maintenance and operation of works during year ending November 30, 1910, | 408,706 35 |
| | <hr/> |
| Balance December 1, 1910, | \$40,869 75 |

This balance includes the sum of \$13,307.38 appropriated for the improvement of the Cochituate watershed, which sum remains for the completion of the improvement.

The Board has also received during the year ending November 30, 1910, \$13,620.20 from rentals, land products and other proceeds from the operations of the Board which, according to section 18 of the Metropolitan Water Act, are applied by the Treasurer of the Commonwealth to the payment of interest on the Metropolitan Water Loan, to sinking fund requirements, and expenses of maintenance and operation of works, thus reducing the amount of the assessment upon the Metropolitan Water District for the year.

Sums received from sales of water to municipalities not belonging to the District and to water companies, and from municipalities for admission to the District, have been applied as follows:—

| | |
|--|--------------|
| For the period prior to December 1, 1906, distributed to the cities and towns of the District, as provided by section 3 of the Metropolitan Water Act, | \$219,865 65 |
| For the period beginning December 1, 1906, and prior to December 1, 1909, applied to the Metropolitan Water Loan Sinking Fund, as provided by chapter 238 of the Acts of 1907, | 16,851 21 |
| For the year beginning December 1, 1909, and ending November 30, 1910, applied to the Metropolitan Water Loan Sinking Fund, as provided by said last-named act, | 3,798 14 |
| | <hr/> |
| | \$240,515 00 |

METROPOLITAN SEWERAGE WORKS.

Construction.

The loans authorized under the various acts of the Legislature for the construction of the Metropolitan Sewerage Works, the receipts which are added to the proceeds of the loans, and the expenditures for construction, are given below, as follows:—

NORTH METROPOLITAN SYSTEM.

| | |
|--|----------------|
| Loans authorized for expenditures for construction under the various acts, including those for the Revere, Belmont and Malden extensions and North System enlargement and extension, | \$6,573,865 73 |
| Receipts from sales of real estate and from miscellaneous sources, which are placed to the credit of the North Metropolitan System:— | |
| For the year ending November 30, 1910, | 123 99 |
| For the period prior to December 1, 1909, | 46,307 18 |
| Amount approved for payment by the Board ¹ out of the Metropolitan Sewerage Loan Fund, North System:— | |
| For the year ending November 30, 1910, | \$194,897 44 |
| For the period prior to December 1, 1909, | 6,303,340 50 |
| | \$6,620,206 90 |
| Balance December 1, 1910, | \$122,058 96 |

SOUTH METROPOLITAN SYSTEM.

| | |
|--|----------------|
| Loans authorized for expenditures for construction under the various acts, applied to the construction of the Charles River valley sewer, Neponset valley sewer, High-level sewer and extension, | \$8,867,046 27 |
| Receipts for pumping, sales of real estate and from miscellaneous sources, which are placed to the credit of the South Metropolitan System:— | |
| For the year ending November 30, 1910, | - |
| For the period prior to December 1, 1909, | 11,406 82 |
| Amount approved by the Board for payment as follows:— | |
| On account of the Charles River valley sewer, | \$800,046 27 |
| On account of the Neponset valley sewer, | 911,531 46 |
| On account of the High-level sewer and extension:— | |
| For the year ending November 30, 1910, | 8,570 75 |
| For the period prior to December 1, 1909, | 7,071,931 65 |
| | \$8,878,453 09 |
| Balance December 1, 1910, | \$86,372 96 |

The loans for the Metropolitan Sewerage Works outstanding at the beginning of the fiscal year amounted to \$15,327,912, and at the end of the year to \$15,440,912. The amount of the Metropolitan Sewerage Sinking Fund was at the beginning of the fiscal year \$1,672,017.97, and at the end of the year was \$1,929,528.07. The net decrease in the debt for the Metropolitan Sewerage Works was \$144,510.10.

Maintenance.

NORTH METROPOLITAN SYSTEM.

| | |
|--|--------------|
| Appropriated for the year ending November 30, 1910, | \$149,000 00 |
| Balance of special appropriation for the restoration and equipment of the East Boston pumping station (1908), remaining, | 13,884 43 |
| Receipts from pumping and from other sources, which are returned to the appropriation:— | |
| For the year ending November 30, 1910, | 3,062 79 |
| | \$165,947 22 |
| Amount approved for payment by the Board:— | |
| For the year ending November 30, 1910, | 159,889 34 |
| Balance December 1, 1910, | \$6,057 88 |

¹ The word "Board" refers to the Metropolitan Sewerage Commission and the Metropolitan Water and Sewerage Board.

This balance of \$6,057.88 includes the sum of \$849.43 which still remains out of the special appropriation for the restoration and equipment of the East Boston pumping station, which have not yet been completed. The general balance remaining is consequently \$5,208.45.

SOUTH METROPOLITAN SYSTEM.

| | | |
|--|-----------|--------------|
| Appropriated for the year ending November 30, 1910, | | \$103,200 00 |
| Receipts from sales of property and for pumping, which are returned to the appropriation:— | | |
| For the year ending November 30, 1910, | | 87 65 |
| Amount approved for payment by the Board:— | | |
| For the year ending November 30, 1910, | | 100,832 60 |
| Balance December 1, 1910, | | \$2,455 05 |

APPENDIX NO. 6.

LEGISLATION OF THE YEAR 1910 AFFECTING THE METROPOLITAN WATER AND SEWERAGE BOARD.

ACTS OF 1910.

[CHAPTER 32.]

AN ACT RELATIVE TO CERTAIN AUTHORIZED ADDITIONS TO
THE METROPOLITAN WATER LOAN.

Be it enacted, etc., as follows:

SECTION 1. Section two of chapter three hundred and twenty of the acts of the year nineteen hundred and nine, being "An Act to authorize the metropolitan water and sewerage board to make certain improvements in the metropolitan water system", is hereby amended by striking out the words and figures "Act of 1909", in the thirteenth line.

1909, 320, § 2,
amended.

SECTION 2. This act shall take effect upon its passage.
[Approved January 31, 1910.]

[CHAPTER 220.]

AN ACT TO PROVIDE FOR SUPERVISION BY THE GOVERNOR AND COUNCIL OF EXPENDITURES AND OTHER FINANCIAL OPERATIONS OF THE COMMONWEALTH.

Be it enacted, etc., as follows:

SECTION 1. Every officer or board having charge of any department, institution or undertaking which receives an annual appropriation of money from the treasury of the commonwealth, including annual appropriations to be met by assessments, shall, annually, on or before the fifteenth day of November, submit to the auditor of the commonwealth statements in detail showing the amount appropriated for the current fiscal year and the amounts required for the ensuing fiscal year, with an explanation of the reason for any in-

Requests for
annual approp-
riations to be
submitted to
auditor and
transmitted to
governor and
council.

creased appropriation, and with citations of the statutes relating thereto, and with a statement of the expenditures for the current year and for each of the next preceding two years. The said estimates shall not include any estimates for special purposes or objects. The auditor of the commonwealth shall embody the said statements, with a like statement relating to his own department, in one document, which shall be printed, and shall be submitted on or before the first Thursday in January of each year to the governor and council for examination, and the governor shall transmit the same to the general court with such recommendations, if any, as he may deem proper. The auditor shall also submit his estimates for the ensuing fiscal year for the ordinary and other revenue of the commonwealth which shall be made a part of the document herein provided for. Copies of the document shall be distributed to the members of the general court.

Requests for
special ap-
propriations to
be submitted to
auditor and
transmitted to
governor and
council.

SECTION 2. Officers, heads of departments, boards, commissions and trustees of institutions, who, in their annual reports, or otherwise, recommend appropriations from the state treasury for special purposes or objects, including appropriations to be met by assessments, in addition to the ordinary running expenses, shall submit estimates thereof in detail to the auditor of the commonwealth on or before the fifteenth day of November in each year, and he shall classify them and embody them in one document which shall be printed, and shall be submitted on or before the first Thursday in January of each year to the governor and council for examination, and the governor shall transmit the same to the general court with such recommendations, if any, as he may deem proper. He shall make recommendation as to how much should be raised by the issue of bonds and how much should be paid out of current revenue. Copies of the document shall be distributed to the members of the general court.

Plans, esti-
mates, etc., to
be submitted
to governor
and council.

SECTION 3. The plans, estimates and specifications made in accordance with the provisions of chapter five hundred and twenty of the acts of the year nineteen hundred and seven, or of amendments thereof, relating to any improvement described in either of the documents aforesaid, shall at the same time be submitted to the governor and council.

Further in-
formation to
be furnished
by auditor.

SECTION 4. The auditor shall furnish to the governor and council such further information in regard to the revenue,

expenditures and other financial operations of the commonwealth, and in such form as the governor may require.

SECTION 5. The governor may, in his discretion, transmit to the general court from time to time, with his recommendations, if any, thereon, particular items in either of the said documents, and may withhold other items for further investigation.

SECTION 6. Section twenty-six of chapter six of the Revised Laws, as amended by section six of chapter two hundred and eleven of the acts of the year nineteen hundred and five and section five of chapter five hundred and ninety-seven of the acts of the year nineteen hundred and eight, and all acts and parts of acts inconsistent herewith, are hereby repealed.

SECTION 7. This act shall take effect upon its passage.

[Approved March 16, 1910.]

Recommendations of the governor to general court.

[CHAPTER 268.]

AN ACT TO PROVIDE FOR THE ANNUAL PREPARATION AND PRINTING OF LISTS OF STATE OFFICIALS AND EMPLOYEES WITH THEIR SALARIES OR COMPENSATION.

Be it enacted, etc., as follows:

SECTION 1. Every department, commission, bureau or board of the commonwealth, shall, on or before the fifteenth day of July in the year nineteen hundred and ten, and on or before the fifteenth day of July in every year thereafter, prepare and furnish to the governor and council lists of all the officials and employees of the commonwealth employed in or by such department, commission, bureau or board on the first day of July preceding, for whose services money has been paid from the treasury of the commonwealth. The said lists shall be arranged by divisions of the several departments, commissions, bureaus or boards, when such divisions exist, and shall give the name, residence, designation, rate of compensation and the date of election or appointment of every such official and employee, and any increase in the rate of salary or compensation for the year preceding; and also the aggregate amount of all money paid for services or salaries to any official or employee, not otherwise shown upon the list, for the year beginning with the first day of July in the year

Lists of officials and employees of the commonwealth to be furnished to the governor and council, etc.

Auditor to
verify lists,
etc.

preceding that in which the list is prepared. It shall be the duty of the auditor of the commonwealth to verify the said lists, the compensation and the said aggregate amounts from the pay roll. The said lists and aggregate amounts shall be printed at the expense of the commonwealth as a document of the commonwealth, before the first day of October in the year in which they are furnished, and the said document shall contain the complete data and facts called for by this act.

SECTION 2. This act shall take effect upon its passage.
[Approved March 22, 1910.]

[CHAPTER 291.]

AN ACT TO AUTHORIZE THE METROPOLITAN WATER AND SEWERAGE BOARD TO MAKE CERTAIN IMPROVEMENTS IN THE METROPOLITAN WATER SYSTEM.

Be it enacted, etc., as follows:

Appropriations for construction for certain purposes in metropolitan water district.

Issue of bonds authorized.

SECTION 1. The sum of one hundred and five thousand dollars shall be allowed and paid out of the treasury of the commonwealth from the Metropolitan Water Loan Fund for the following purposes:—For a thirty-six inch main for the improvement of the supply of the East Boston district of the city of Boston; and for a new main for the extension of the high-service district in Arlington and Lexington.

SECTION 2. For the purposes aforesaid the metropolitan water and sewerage board may, in addition to providing for the improvements for which expenditures have hitherto been authorized, expend any sum heretofore appropriated for the construction of the metropolitan water works. To meet the further expenditures incurred under the provisions of this act, and not so provided for, the treasurer and receiver general shall, from time to time, issue upon the request of said board, bonds in the name and behalf of the commonwealth, to be designated on the face thereof, Metropolitan Water Loan, to an amount not exceeding eighty thousand dollars, in addition to the sum of forty-one million seven hundred and ninety-eight thousand dollars authorized to be issued by chapter four hundred and eighty-eight of the acts of the year eighteen hundred and ninety-five and acts in addition thereto, and the provisions of said chapter four hundred and eighty-

eight and acts in amendment thereof and in addition thereto shall apply to this additional loan.

SECTION 3. This act shall take effect upon its passage.
[Approved March 25, 1910.

[CHAPTER 292.]

AN ACT TO AUTHORIZE THE METROPOLITAN WATER AND SEWERAGE BOARD TO ENABLE THE CITY OF QUINCY TO DRAIN ITS TERRITORY INTO THE HIGH-LEVEL SEWER.

Be it enacted, etc., as follows:

SECTION 1. The metropolitan water and sewerage board is hereby authorized to expend from the balance remaining of the Metropolitan Sewerage Loan Fund, South System, such sum as may be required in compliance with section eight of chapter four hundred and twenty-four of the acts of the year eighteen hundred and ninety-nine for the construction of such works as may be necessary in order to enable the city of Quincy to drain by gravity its territory into the high-level sewer.

The city of
Quincy may
drain its
territory into
the high-level
sewer.

SECTION 2. This act shall take effect upon its passage.
[Approved March 25, 1910.

[CHAPTER 340.]

AN ACT MAKING AN APPROPRIATION FOR OPERATING THE SOUTH METROPOLITAN SYSTEM OF SEWAGE DISPOSAL.

Be it enacted, etc., as follows:

SECTION 1. A sum not exceeding one hundred and three thousand two hundred dollars is hereby appropriated, to be paid out of the South Metropolitan System Maintenance Fund, for the cost of maintenance and operation of the south metropolitan system of sewage disposal, comprising a part of Boston, the cities of Newton and Waltham, and the towns of Brookline, Watertown, Dedham, Hyde Park and Milton, during the fiscal year ending on the thirtieth day of November, nineteen hundred and ten.

Appropriation
for mainte-
nance of south
metropolitan
sewerage
system.

SECTION 2. This act shall take effect upon its passage.
[Approved April 2, 1910.

[CHAPTER 341.]

AN ACT MAKING AN APPROPRIATION FOR OPERATING THE METROPOLITAN WATER SYSTEM.

Be it enacted, etc., as follows:

Appropriation
for main-
tenance of
metropolitan
water works.

SECTION 1. A sum not exceeding four hundred and twenty thousand dollars is hereby appropriated, to be paid out of the Metropolitan Water Maintenance Fund, for the maintenance and operation of the metropolitan water system for the cities and towns in what is known as the metropolitan water district, during the fiscal year ending on the thirtieth day of November, nineteen hundred and ten.

SECTION 2. This act shall take effect upon its passage.
[Approved April 2, 1910.]

[CHAPTER 359.]

AN ACT RELATIVE TO APPOINTMENT AND EMPLOYMENT IN THE PUBLIC SERVICE IN VIOLATION OF THE CIVIL SERVICE LAW OR RULES.

Be it enacted, etc., as follows:

R. L. 19, § 34,
amended.

Enforcement
of civil service
rules.

Chapter nineteen of the Revised Laws is hereby amended by striking out section thirty-four and inserting in place thereof the following:—*Section 34.* If, in the opinion of the civil service commission, a person is appointed or employed in the public service classified under civil service rules, in violation of the civil service law, or of the said rules, the commission shall, after written notice mailed to the appointing or employing officer or officers, and to such person, notify in writing the treasurer, auditor or other disbursing officer of the commonwealth, city or town, in whose service or by which such person is so employed or paid; and the payment of any salary or compensation to such person shall be illegal and shall cease at the expiration of one week after the mailing of the latter notice, and until the legality of such appointment or employment is duly established. It shall be unlawful for the treasurer, auditor or other disbursing officer of the commonwealth, or of such city or town to draw, sign or issue, or to authorize the drawing, signing or issuing of any warrant, or to make payment of any salary or compensation

to the person so found by the civil service commission to be illegally appointed or employed. Any person so found by the civil service commission to be illegally appointed or employed may file a petition for a writ of mandamus in the superior or supreme judicial court to compel the civil service commission to authorize such appointment, or employment, and the payment of compensation or salary therefor. At any time after the filing of such petition the court, if it is of opinion that there is reasonable doubt whether the appointment or employment of such person is in violation of the civil service law or rules, may order that the compensation accruing to such person shall be paid to him until otherwise ordered by said court. [Approved April 8, 1910.]

Petition for
writ of
mandamus
may be filed,
etc.

[CHAPTER 388.]

AN ACT MAKING AN APPROPRIATION FOR OPERATING THE NORTH METROPOLITAN SYSTEM OF SEWAGE DISPOSAL.

Be it enacted, etc., as follows:

SECTION 1. A sum not exceeding one hundred and forty-nine thousand dollars is hereby appropriated, to be paid out of the North Metropolitan System Maintenance Fund, for the maintenance and operation of the system of sewage disposal for the cities included in what is known as the north metropolitan system, during the fiscal year ending on the thirtieth day of November, nineteen hundred and ten.

Appropriation
for mainte-
nance of north
metropolitan
sewerage
system.

SECTION 2. This act shall take effect upon its passage.
[Approved April 13, 1910.]

[CHAPTER 452.]

AN ACT RELATIVE TO THE RECOMMENDATIONS FOR LEGISLATION IN THE ANNUAL REPORTS OF STATE BOARDS AND COMMISSIONS.

Be it enacted, etc., as follows:

SECTION 1. Section six of chapter eighteen of the Revised Laws is hereby amended by inserting after the word "action", in the sixth line, the words:—such recommendations or suggestions to be accompanied by drafts of bills

R. L. 18, § 6,
amended.

Recommendations for legislation, etc.

embodying the legislation recommended,— so as to read as follows:— *Section 6.* State boards and commissions shall annually, on or before the first Wednesday in January, deposit with the secretary of the commonwealth such parts of their annual reports which are required to be made to the governor and council or to the general court as contain recommendations or suggestions for legislative action, such recommendations or suggestions to be accompanied by drafts of bills embodying the legislation recommended; and the secretary shall forthwith transmit them to the governor and council or to the general court.

SECTION 2. This act shall take effect upon its passage.
[Approved April 27, 1910.]

[CHAPTER 500.]

AN ACT RELATIVE TO HEARINGS GIVEN TO VETERANS IN THE PUBLIC SERVICE.

Be it enacted, etc., as follows:

R. L. 19,
§ 23, etc.,
amended.

Veterans not
to be removed
without a
hearing, etc.

SECTION 1. Section twenty-three of chapter nineteen of the Revised Laws, as amended by chapter one hundred and fifty of the acts of the year nineteen hundred and five, is hereby further amended by striking out the said section and inserting in place thereof the following:— *Section 23.* No veteran who holds an office or employment in the public service of the commonwealth or of any city or town therein, shall be removed or suspended, or shall, without his consent, be transferred from such office or employment, nor shall his office be abolished, nor shall he be lowered in rank or compensation, except after a full hearing of which he shall have at least seventy-two hours' written notice, with a statement of the reasons for the contemplated removal, suspension, transfer, lowering in rank or compensation, or abolition. The hearing shall be before the state board of conciliation and arbitration, if the veteran is a state employee, and before the selectmen of the town of which he is an employee, if the veteran is a town employee. If the veteran is a city employee the hearing shall be held before the board of aldermen of the city of which the veteran is an employee. In case the city of which the veteran is an employee has not a board of aldermen, the hearing shall be held before the city council of such city. At any hearing

where the veteran is a party in interest, he shall have the right to be present and to be represented by counsel. The said removal, suspension or transfer, lowering in rank or compensation, or abolition of an office, shall be made only upon a written order stating fully and specifically the cause or causes therefor, and signed by the state board of conciliation and arbitration, or selectmen, or said members of the city government, as the case may be, after a hearing as aforesaid.

SECTION 2. This act shall take effect upon its passage.

(*The foregoing was laid before the Governor on the third day of May, 1910, and after five days it had "the force of a law", as prescribed by the Constitution, as it was not returned by him with his objections thereto within that time.*)

[CHAPTER 515.]

AN ACT RELATIVE TO THE TAXATION OF PROPERTY HELD BY THE METROPOLITAN WATER AND SEWERAGE BOARD IN THE TOWN OF CLINTON AND TO THE SALE OR DISPOSAL OF ELECTRICITY BY SAID BOARD.

Be it enacted, etc., as follows:

SECTION 1. The property held by the metropolitan water and sewerage board, or its successors, in the town of Clinton which may be subject to taxation under the provisions of section two of chapter four hundred and ninety-eight of the acts of the year nineteen hundred and six shall be assessed on a valuation of one hundred and twenty-five thousand dollars in any year in which any power is generated and sold.

Taxation of
property held
by metropolitan
water and
sewerage board
in town of
Clinton.

SECTION 2. In the sale or disposal of electricity generated in the town of Clinton for power or manufacturing purposes under the provisions of section three of chapter four hundred and eighty-eight of the acts of the year eighteen hundred and ninety-five, preference shall be given to persons or corporations proposing to use all of such electricity in the town of Clinton: *provided*, that there are responsible persons or corporations so proposing to use all the electricity in said town who shall offer to purchase the same on terms as advantageous as shall be offered by others not so proposing to use the same; and the said board shall, at least ten days before making a contract for the sale of such electricity, cause to be printed in some newspaper published in said town a request for pro-

Sale or
disposal of
electricity.

Proviso.

posals for the purchase of the electricity to be generated and sold by said board.

SECTION 3. This act shall take effect upon its passage.
[Approved May 13, 1910.]

[CHAPTER 546.]

AN ACT TO PROVIDE FOR THE ADDITION OF THE TOWN OF BRAINTREE TO THE SOUTH METROPOLITAN SEWERAGE SYSTEM.

Be it enacted, etc., as follows:

Town of Braintree added to the south metropolitan sewerage district.

SECTION 1. The territory comprising the town of Braintree is hereby added to the south metropolitan sewerage district, created by chapter four hundred and twenty-four of the acts of the year eighteen hundred and ninety-nine. In becoming a part of the said system said town shall be subject to the provisions and shall conform to the requirements of said act and acts in amendment thereof and in addition thereto, except as is otherwise provided herein. Any authority granted to other municipalities by said act or acts in amendment thereof and in addition thereto is also vested in the town of Braintree, in common with such other municipalities.

Outlet to be provided at the Braintree town line, etc.

SECTION 2. The metropolitan water and sewerage board shall provide an outlet at the Braintree town line for the sewerage of said town, and, acting on behalf of the commonwealth, shall construct a main trunk sewer or sewers through such parts of the city of Quincy to such point in the south metropolitan system as said board may determine to be necessary in order to make connection with the high-level sewer.

The metropolitan water and sewerage board to exercise certain authority, etc.

SECTION 3. In providing for such outlet and in receiving sewage from the town of Braintree, and in any action relating thereto, and for the purpose of taking, constructing and maintaining such additional main lines of sewers, the said metropolitan water and sewerage board, acting on behalf of the commonwealth, shall have and exercise all the authority conferred upon it by chapter four hundred and thirty-nine of the acts of the year eighteen hundred and eighty-nine and by chapter one hundred and sixty-eight of the acts of the year nineteen hundred and one, and by acts in amendment thereof and in addition thereto; and all the provisions of said acts are made applicable to the additional construction, mainte-

nance and operation hereby authorized except as otherwise provided herein.

SECTION 4. To meet the expenses incurred under the provisions of this act, the treasurer of the commonwealth shall from time to time issue in the name and behalf of the commonwealth and under its seal bonds designated on the face thereof, Metropolitan Sewerage Loan, for a term not exceeding thirty years, to an amount not exceeding one hundred thousand dollars in addition to the amount of such bonds heretofore authorized for the construction of the south metropolitan sewerage works. The provisions of chapter four hundred and twenty-four of the acts of the year eighteen hundred and ninety-nine and all acts in amendment thereof and in addition thereto shall, so far as they are applicable, apply to the indebtedness authorized by this act.

Metropolitan
Sewerage
Loan.

SECTION 5. The interest and sinking fund requirements on account of the moneys expended in constructing that part of the sewerage system provided for in this act, and the cost of maintenance and operation thereof, shall be deemed and paid as a part of the interest, sinking fund requirements and costs specified in said chapter four hundred and twenty-four of the acts of the year eighteen hundred and ninety-nine and acts in amendment thereof and in addition thereto, and shall be apportioned, assessed and collected in the manner provided by that chapter and acts in amendment thereof and in addition thereto except as is otherwise provided herein. The town of Braintree shall, in addition to the yearly payment of the assessment so provided for, pay into the treasury of the commonwealth for the sinking fund of the south metropolitan sewerage district such proportion of the total amount of said sinking fund, as existing on the first day of May in the year of its admission to the south metropolitan district, as the valuation of the said town for the said year shall bear to the total amount of the valuation of said district, as determined for the purposes of apportionment of assessments; and the town shall also pay the further sum of one thousand dollars. Such proportion shall be determined by the metropolitan water and sewerage board and shall be certified by said board to the treasurer of the commonwealth. The treasurer shall determine the total amount so to be paid by said town on account of its admission to the district, and for

Certain
provisions of
law to apply.

Payment of
loans, etc.

the payment thereof shall add one fifth of said total amount to the yearly sum payable by said town on account of its share of the interest and sinking fund requirements of the district for the succeeding five years. No assessment on account of maintenance requirements of the south metropolitan sewerage district shall be made upon said town until the calendar year in which its sewers shall be connected with the south metropolitan system as herein provided.

Time of taking effect.

SECTION 6. This act shall take effect when accepted by vote of the majority of the legal voters of the town of Braintree present and voting thereon at a meeting legally called for the purpose. [Approved May 23, 1910.]

[CHAPTER 547.]

AN ACT TO PROVIDE FOR AN OUTLET FOR THE SEWAGE OF THE CITIES OF MALDEN AND EVERETT INTO THE NORTH METROPOLITAN SEWERAGE SYSTEM.

Be it enacted, etc., as follows:

Additional outlet for the sewage of Malden and Everett to be provided.

SECTION 1. The metropolitan water and sewerage board may, in order to provide an additional outlet for the sewage of the cities of Malden and Everett, acting in behalf of the commonwealth, take, or acquire by purchase or otherwise, the existing sewer belonging to the city of Malden from a point at or near the corner of Eastern avenue and Bryant street in said city and running northerly through Eastern avenue to a point at or near the middle of Broadway; and the said board is hereby authorized to pay to the city of Malden the actual cost of the construction of the portion of the sewer so taken, less such assessments as have been collected prior to the date of such taking. The said portion of the sewer when so taken shall become a part of the north metropolitan system of sewers. Upon acquiring the portion of the sewer in Eastern avenue as aforesaid the said board shall proceed to construct a sewer extending from said sewer through Broadway to a point at or near the boundary line between the cities of Malden and Everett, and the sewer so constructed shall become a part of the north metropolitan system. The city of Everett may, under the direction of said board, connect its local system of sewers with said metropolitan sewer

in Broadway. The city of Malden may, under the direction of said board, connect its local system of sewers with the said metropolitan sewers in Broadway and Eastern avenue and may also, subject to such direction, make and maintain house connections with the said sewer. The city of Malden shall make assessments of annual rates for said metropolitan sewers in Broadway and Eastern avenue in the same manner in which such assessments are now made in said city for its local sewers. All such sums as may be assessed therefor shall be paid by the treasurer of said city into the treasury of the commonwealth, except such assessments as may be collected upon the portion of said sewer in Eastern avenue between Faulkner and Bryant streets, and shall be credited to and become a part of the Metropolitan Sewerage Loan Fund authorized by chapter four hundred and thirty-nine of the acts of the year eighteen hundred and eighty-nine and acts in amendment thereof and in addition thereto.

SECTION 2. For the purpose of taking and constructing said metropolitan sewers in Eastern avenue and Broadway and for the operation and maintenance thereof, the said board, acting in behalf of the commonwealth, shall have and exercise all the authority conferred upon it by chapter four hundred and thirty-nine of the acts of the year eighteen hundred and eighty-nine and all acts in amendment thereof and in addition thereto, and all the provisions of said acts are made applicable to the taking, construction, maintenance and operation of said sewers except as is otherwise provided herein.

SECTION 3. To meet the expenses incurred under the provisions of this act the treasurer and receiver general shall, from time to time, issue in the name and behalf of the commonwealth and under its seal bonds designated on the face thereof Metropolitan Sewerage Loan, for a term not exceeding thirty years, to an amount not exceeding fifty-six thousand dollars, in addition to the amount of such bonds heretofore authorized for the construction of the north metropolitan sewerage works. The provisions of chapter four hundred and thirty-nine of the acts of the year eighteen hundred and eighty-nine and of chapter four hundred and twenty-four of the acts of the year eighteen hundred and ninety-eight and

The metropolitan water and sewerage board to exercise certain authority, etc.

Metropolitan
Sewerage
Loan.

Certain
provisions of
law to apply.

all acts in amendment thereof and in addition thereto shall, so far as they may be applicable, apply to the indebtedness authorized by this act.

*Payment of
loans, etc.*

SECTION 4. The treasurer and receiver general shall, in addition to levying the assessments now required by law to meet the interest and sinking fund requirements of the north metropolitan system, assess annually upon the cities of Malden and Everett, in equal shares, such sums as may be necessary to satisfy the interest and sinking fund requirements of the bonds issued under the provisions of this act.

SECTION 5. This act shall take effect upon its passage.
[Approved May 23, 1910.]

[CHAPTER 550.]

AN ACT RELATIVE TO THE POLLUTION OF CERTAIN SOURCES
 OF WATER SUPPLY.

Be it enacted, etc., as follows:

R. L. 75, § 123,
 amended.

Not to apply
 to certain
 rivers, etc.

Section one hundred and twenty-three of chapter seventy-five of the Revised Laws is hereby amended by striking out the said section and inserting in place thereof the following:

— *Section 123.* The provisions of the preceding eleven sections shall not apply to the Connecticut river. The provisions of the preceding five sections and of so much of sections one hundred and twelve to one hundred and seventeen, inclusive, as refers to domestic water supplies shall not apply to the Merrimac river, nor to so much of the Concord river as lies within the limits of the city of Lowell, nor to springs, streams, ponds or water courses over which the metropolitan water and sewerage board has control. *[Approved May 23, 1910.]*

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